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"ARTIFICIAL INTELLIGENCE IN ITALIAN MANUFACTURING: GROWTH POTENTIALS AND CRITICALITIES"

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Firma dello studente

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INTRODUCTION

Today's world, from a technological point of view, is constantly evolving.

A company that wants to achieve a sustainable competitive advantage over time cannot longer focus solely on a workforce excellently skilled: this, in fact, remain necessary, but no longer sufficient.

It is no longer possible to ignore the multitude of technologies and innovations that companies have at their disposal. Entrepreneurs, companies' owners and top managers have to avoid to remain anchored to a mentality fearful of change; they, instead, have to work in order to exploit all the benefits related to the area of "corporate technologies".

The aim of this *experimental Master Thesis* is to show what are the growth potentials and opportunities in implementing the *Artificial Intelligence*, one of the most advanced technologies in the corporate world, but which continues to be considered as a "frontier technology".

In the following analysis concerning Artificial Intelligence, however, all the risks and criticalities that the introduction of such advanced technology may entail will not be overlooked; indeed, it is necessary to emphasize that the limits of this technology are still high and that the studies in this field are still in an evolutionary phase.

The first chapter, after a brief analysis of Turing's approach to AI and the Simon's theory of individuals' bounded rationality, will move to an in-depth analysis of the Artificial Intelligence topic, with a particular focus on the role of Data and Business Intelligence in the application of such technology.

To be defined as Intelligent, an AI software requires Data to be gathered, analyzed and managed in the best possible way.

In the final part of the first chapter will be analyzed a portion of the paper by Andrew NG, co-founder of Google Brain, that shows the key aspects in which a company must focus in order to implement the AI within its business.

The second chapter will highlight the versatility of Artificial Intelligence and how it can be exploited in different business areas, such as:

- *Marketing;*
- *Human Resources;*
- *Supply Chain Management.*

Furthermore, the second chapter will point out the fiscal benefits and tax advantages that Italian companies can exploit in case of Artificial Intelligence implementation (and in general on technologies related to Industry 4.0).

In the third chapter it will be possible to observe the AI's "Best in class application" by innovation giants like Google, Amazon and IBM; these multinationals offer several AI services which the SMEs can benefit from.

Almost all the major Internet multinational companies have launched, in 2016, a partnership to promote and deepen the Artificial Intelligence world; this partnership is called "*partnership on AI to benefit people and society*".

The main aim of the members of this partnership, as it will be shown in the third chapter, is to convince governments and citizens that the Artificial Intelligence is not a danger, but an opportunity.

The fourth and final chapter will show the results of the *Qualitative Research* carried out by the undersigned, under the supervision of Professor Bettiol of the *Department of Economic and Business Sciences* of the University of Padua.

The choice to opt for a Qualitative Analysis, rather than on a Quantitative one, lies in the need to dig deep into the theme of Artificial Intelligence, which is still limitedly explored from the business application point of view.

Moreover, the narrow number of Italian manufacturing companies that have already implemented this technology made the choice of a quantitative research impractical.

The aim of this Qualitative Analysis is to enter within the Italian manufacturing world, in order to assess the strengths and weaknesses that manufacturing companies have had to face in the application and introduction of this technology.

The companies subject to the analysis have been selected within the *Champion companies* that have declared – in a research made by the Department of Economic and Business Sciences of the University of Padua - that they use technologies associated with Artificial Intelligence.

CHAPTER 1:

Introductory analysis of the *Artificial Intelligence*.

1.1 Artificial Intelligence: Historical Overview

"Can machines think?"; this question, despite it seems current, was first formulated by Alan Turing in 1950.

The question, in fact, represents the beginning of one of the most famous articles by Alan Turing, called *Computing machinery and intelligence*, which dealt with the most advanced scientific topic of those years: Artificial Intelligence.[1]

Alan Turing played an crucial role, thanks to his mathematical skills, in the English war effort. In fact, during the II World War, he took part in the realization of machines capable to deciphering and to defeat "Enigma", the cryptographic device used to communicate secretly by the German army. During the war he participated in and directed a program at the Government Code and Cypher School (GCCS) of Bletchley Park, the allied institution committed to deciphering the enemy secret codes.[2]

Turing can be considered as the “father” of Artificial Intelligence, as he was the first to understand the potential of automatic computing; he believed, in the early XX century, that computers would one day be able to emulate the functioning of the human mind.

Today it is possible to affirm that Turing’s idea about the “thinking machines” was not completely wrong. Indeed, the theme of Artificial Intelligence is becoming every day more dominant in the contemporary society.

This is particularly visible from the development of new Machine Learning systems applied to a wide range of different activities with considerable automation capacity.

1.1.1 The Turing Test.

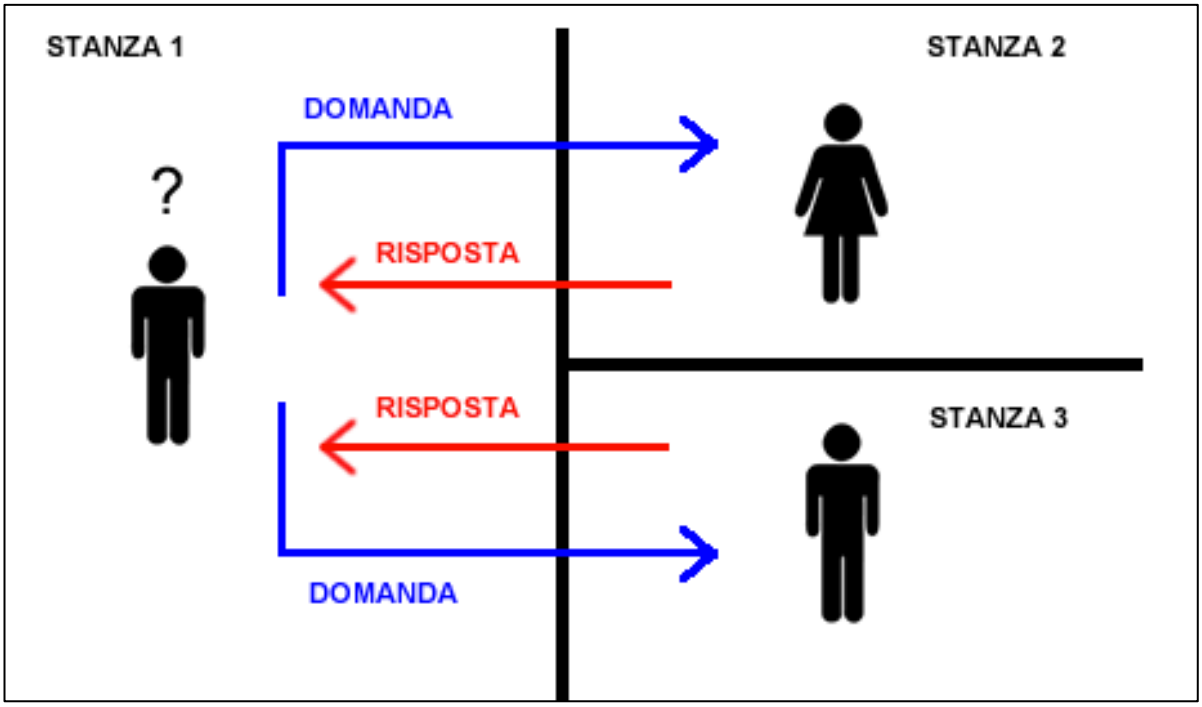
Alan Turing in 1950 conceives his test: an experiment to understand whether a machine can be considered intelligent or not.

The main innovation in Turing's work was to provide an “operational” definition of intelligence, in a perspective that turned attention to *behavior* rather than on *thought processes* and *reasoning processes (Petrocelli, 2014).*

[1] https://www.cyberlaws.it/2018/la-storia-dellintelligenza-artificiale-da-turing-ad-oggi/

[2] https://www.ilsole24ore.com/art/tecnologie/2012-06-21/turing-enigma-153636.shtml?uuid=AbIVQzvF

The complexity of Turing's reasoning can be summarized in the following assumption: if the behavior of a machine is indistinguishable from that of a human, then that machine can be considered intelligent.
For the test verification, Turing defines a two-stage “imitation game”.

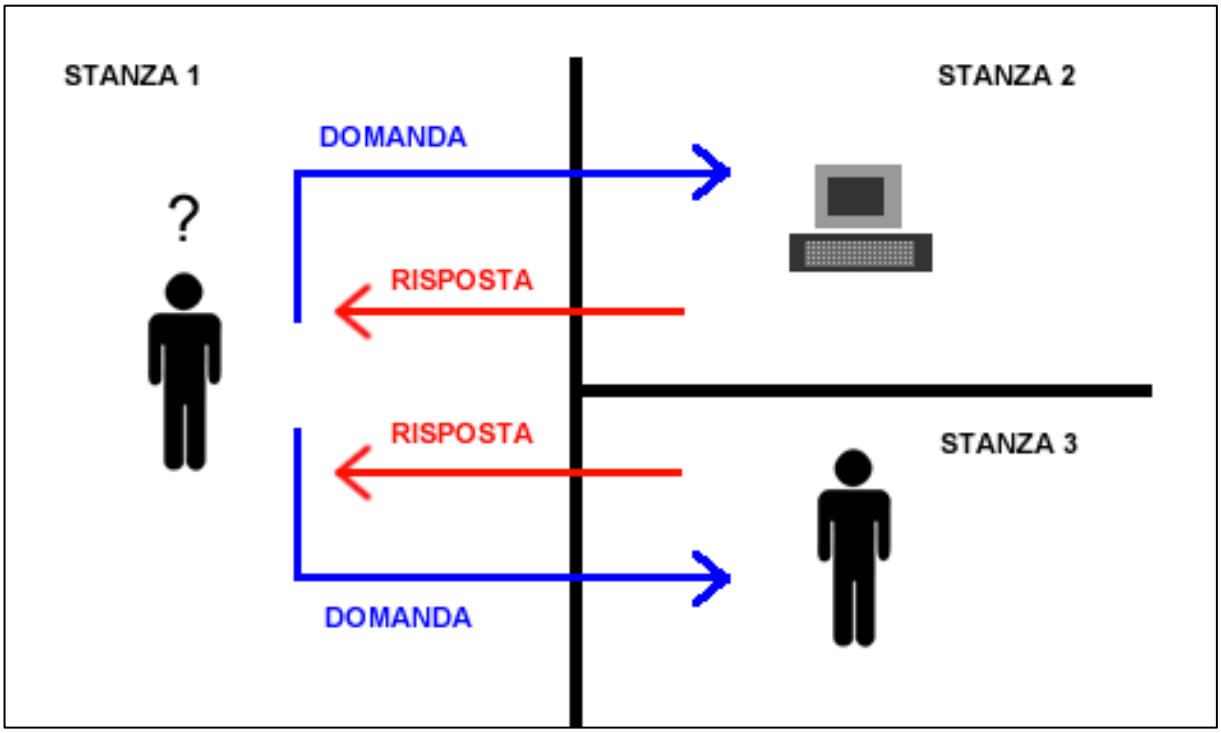


Source: http://www.andreaminini.com/ai/test-di-turing/

In the first phase three people are involved: a man (A), a woman (B), and an interrogator (Q) separated from the other two and able to communicate with them only through a teletype.
The purpose of the interrogator during the first phase of the game is to distinguish which one, between A and B, is the man and which is instead the woman. To find out the sex of A and B, the interrogator has the chance to ask a set of questions through the teletype and reading the relative answers.

The two participants (A and B) have different purposes: a participant is sincere, so he/she has the objective of facilitating the identification by the interviewer.
The second participant, instead, provides untruthful answers in order to make the interviewer misidentify the real sex of A and B. The interviewer does not know who lies and who is sincere. He must be able to figure it out for himself. At the end of the game the interviewer must decide which of the two participants is the man and who is the woman.

In the second phase of the game, a computer intervenes in place of a randomly chosen subject between A and B.



Source: http://www.andreaminini.com/ai/test-di-turing/

Even in this second phase the process remains the same; as before, in fact, the interrogator formulates questions to participants via teletype and he cannot see them. He doesn't know if he's talking with a man and a woman or if one of them is a computer.

At the end of the game, the interrogator must identify which one is a human and which one, instead, is a computer, based solely on their written answers.

The Turing Test is passed if the percentage of error of the interrogator in the second phase of the game (where the interrogator has to identify which is the computer) is similar to the percentage of error of the first phase (where the interrogator has to identify the man and the woman).

According to Turing, a machine capable to pass his test can be defined as “intelligent”.

As described by Carla Petrocelli (2014), a computer able to succeed in the *Turing test* should have advanced capabilities, such as:

- *the ability to interpret the natural language*, in order to understand the questions of the interrogator, and to produce answers as a human;

- *the ability to represent the knowledge* needed to store information before and during the dialogue;
- *the capacity of automatic reasoning*, in order to use the acquired knowledge to answer questions and draw new conclusions;
- *the ability to learn, to adapt to new circumstances, to identify and extrapolate schemes* not yet present in the knowledge base.

1.1.2 Bounded rationality.

Prior to go deeper in the Artificial Intelligence world, it is important to make a step back and to focus on human's cognitive ability and on its impact on the evolution of the economic thought.

The classical economic theory assumes, among its fundamental hypotheses, the **absolute rationality** of economic operators. In particular, the classical economic theory (Costa et al, 2014) provides the characteristics that the so-called "homo oeconomicus" should have:

- he/she knows all the alternatives available and the consequences of each alternative;
- he/she possesses a complete calculation ability;
- he/she acts in *conditions of certainty* in the evaluation of the consequences of each alternative.

In summary, according to the classical theory, the market operator knows all the utility functions of all the choices, so he is provided with *absolute rationality*.

This aspect finds its basis of legitimacy in science and in the concept of "One Best Way", the assumption that for every problem there is only one optimal solution and that this solution can be reached with adequate scientific research methods. (Costa et al, 2014)

According to the absolute rationality concept, the individuals are used to making a decision based on the optimization criterion, in search of the absolute best solution; this implies that an individual can orient his action in a linear and completely predictable way, being able to control the outcomes of his own action and organizing in a preventive way the solutions to possible unforeseen events; in other words, his cognitive abilities allow him to evaluate the present state and prefigure without error any future states, or effects, of his own action (Lipari, 1987).

It is a model of rationality that implies the possibility of being able to predict the world based on perfect information.

This model, deriving from the classical economic theory, appears to be unrealistic as the individuals do not have all the tools and capabilities to predict every future consequence of their actions and to identify in an "absolute" manner the *One Best Way*.

For this reason, the concept of absolute rationality has been overcome by the US economist Herbert Simon through his theory of the *bounded rationality*, where the economic agents:

- have incomplete information.
- have limited computational capacity.
- are rational, but their rationality is not absolute.

According to the bounded rationality theory the individuals should adapt themselves to the changing environment and, once done it, they should seek the most satisfactory solution among all the alternatives.

In order to find most satisfactory solution in the given situation, the agents should follow the *Satisficing Principle*, that represents the alternative to the optimization criteria (Zouboulakis, 2014).

According to Simon the human mind - due to its own objective limitations, that make it impossible to provide complete information and forecast accuracy - is not able to find optimal solutions to problems. As a consequence, the choices have to be made based on the criteria of the local and contingent rationality, which is proper of an individual at a specific point in time and in a specific context.

This kind of rationality leads him/her to adopt not the best solution ever, but the one that is the most satisfying in that moment and in that context (Lipari, 1987).

The idea of bounded rationality refers to a non-idealized model of human being, that instead is anchored to the context. The individuals are endowed with a limited mind, incapable of foreseeing everything, but rather able to find optimal solutions, acceptable and adequate to the situations.

At this point it is clear that the human mind, due to its own objective limitations that make it impossible to provide complete information and forecast accuracy, is not able to find optimal solutions to problems - contrary to what is asserted by the theory of absolute rationality.

Summing up:

- the *absolute rationality model* is characterized by the existence of a limited series of alternatives in the decision-making process and a known distribution of the probabilities of the results. The individual is therefore able to take the absolute best choice.
- in the case of *bounded rationality* the alternatives are generated within the process itself. The individuals have to make an estimation of the results of the possible alternatives and then they have to choose the alternative that best satisfy their needs.

1.1.3 Organizational Learning.

Although belonging to two distinct theoretical traditions, cognitivism and phenomenology focus more on the individual than on the system. While, on one hand, the *phenomenological trend* analyzes the processes by which individuals interact generating an organizational culture, on the other the *cognitive trend* conceives the organizational structure as a system that processes information.

The latter is based on the idea of individual's limited rationality and on the notion of organization considered as a process for actions and decisions (with control functions on different rationalities towards the achievement of objectives).

The topic of information processing within the organization was addressed by Simon and March (Maraschi and Fiorentino, 2011).

Because people have limited information processing capabilities, organizations can never be perfectly rational.

The following can be considered as the main limitations of human rationality:

- make decisions based on incomplete information;
- ability to analyze only a *limited amount of alternatives* in order to make decisions;
- inability to comprehensively evaluate the results of individual actions.

According to Simon, all the aspects listed above are institutionalized in the structures and operating methods of the organizations, which tries to routinize the decision-making processes in order to be able to manage them.

Furthermore, Simon argues that organizations are the result of the ability to process information; therefore, organizations will become smarter if they are able to develop a high learning capacity (Maraschi and Fiorentino, 2011).

Gareth Morgan (2007), a British organizational theorist, describes the skills through which an organization can develop its learning skills:

- organizational environments must be able to perceive and research significant aspects of their environment;
- the systems must be able to link the information gathered to the operational rules, which guide the behavior;
- the systems must be able to identify any significant deviations from these standards;
- the systems must be able to develop corrective actions when deviations are detected.

The company may face obstacles that reduce their learning skills, including:
- bureaucratic organizations where knowledge is fragmented and where information does not circulate freely;
- inconsistency between what is declared and practical theory;
- systems that reward successes and sanction mistakes push employees to be interested only in problems that are easy to solve.

At the same time, however, there are also actions that can increase the company's learning skills, including:
- avoid setting specific targets and favoring an approach to solving complex problems;
- foster an open-minded attitude that accepts error as an inevitable element;
- create organizational structures and processes suitable for this type of action.

An innovative tool such as Artificial Intelligence can become crucial in increasing the capacity for organizational learning and in helping the organization to overcome learning obstacles.

1.1.4 Artificial Intelligence limitations.

One of the main limitations of the human mind is to be bounded and one of the main potential of an Artificial Intelligence software are those of crossing the wall of bounded rationality and acting trying to foresee the consequence of every possible action.
One of the main distinctive features of the human species is the ability to feel emotions and the one of being empathetic with others even because human are able to recognize sadness or joy, for example, in the face of one's fellows.
Artificial Intelligence systems are improving their ability to replicate different aspects of learning and human intelligence; but how could the AI software act, instead, when the choice to be made needs of empathy and emotions?
The problem is that Artificial Intelligence lacks emotional intelligence and therefore is not able to classify human feelings and moods in points or profiles of unique data.
For this reason, one of the main limits of Artificial Intelligence towards human intelligence is precisely that of feeling emotions, which play a crucial role in a work environment and within a company.
Another crucial limit of Artificial Intelligence regards the need to obtain a very high amount of data in order to work at its best: it is called *Data Hungry*.

The authors Mohanty e Vyas - in their book *How to Compete in the age of Artificial Intelligence (2018)* – say that "AI applications are data-hungry products. To train your AI application, you not only require a lot of data, but also robust data management practices. You'll need to identify data sources, build data pipelines, clean and prepare data, identify potential signals in your data, and measure your results.

With the increase in the amount of data produced and analyzed within the enterprise and outside, there is a growing problem that enterprises are starting at – being drowned in a sea of data, analysis, dashboard and data portals." (Mohanty and Vyas, 2018, p.21).

An individual that have to face a scenario never seen before, is in almost all cases able to make a decision, thanks to the human ability to adapt to change and to manage uncertainty.

A software with Artificial Intelligence "learns" how to behave based on the data it receives, therefore it may not be able to complete a task that it has never faced before and for which it has no data to refer to. The *Machine learning* has the primary objective of solving this problem, but the error rates are currently very high.

Moreover, the machine is not equipped with instinct, which represents a purely human characteristic.

The Instinct can also be replicated with an algorithm capable of associating each stimulus with a particular action. The instinct algorithm is basically a list of if/do statements: the machine perceives the external stimulus through sensors, and subsequently responds to the stimulus based on the previous programming; obviously this type of instinct cannot be compared to the human one, which is characterized by a superior adaptability.

1.2 Industry 4.0: General Overview

After having briefly analyzed the history of Artificial Intelligence, the potential of this technology with respect to the human mind, but also its limitations, and prior to go deeper into to AI world, it is necessary to have a general overview of Industry 4.0 universe.

The term ***Industry 4.0*** refers to the constant process of industrial automation, characterized by the introduction of new production technologies, in order to increase productivity and production quality of the plants.

The scholar Christoph Bartodziej - in his book *The Concept Industry 4.0: an Empirical Analysis of technologies and applications in Production Logistic* (2017) - describes the way in which the concept of Industry 4.0 was born and its evolution in the last years; the notion of *Industry 4.0* was launched by the Communication Promoters Group of the Industry-Science Research Alliance (FU) in 2011, defining it as "[…] the fourth industrial revolution, a new level of

organization and control of whole value chains over the entire lifecycle of products. […] The basis for the development is formed by the availability of all necessary information in real-time through interconnection of all instances which are involved in value creation […]" (Bartodziej 2017, p.33-34)

Kagermann (2013) presented a clearer definition of Industry 4.0:

"[…] the technical integration of CPS into manufacturing and logistics and the use of the Internet of Things and Services in industrial processes. This will have implications for value creation, business models, downstream services and work organization." (Kagermann et al. 2013, p.18).

The *Cyber-Physical System* (CPS) are computer systems that allow machines to communicate and operate in close contact with the real world.

Generally speaking, the main aim of the Industry 4.0 is to make the factory "*smart*".

A company that has been able to substitute its production processes with smart and automated systems - that are able to operate autonomously and closely related with the external environment - can be defined as *smart factory*.

The *Italian Ministry of Economic Development* published, the 4th July 2018, a report called "La diffusione delle imprese 4.0 e le politiche: evidenze 2017" in which it shows the implementation and utilization rate of the 4.0 technologies in the Italian corporations.

In particular, it took into consideration a sample of 23.700 companies (coming from different Italian regions) among which the 8.4% of Italian manufacturing companies use at least a 4.0 technology; in addition, the 4.7% of the companies of the sample are planning specific investments over the next three years.

Even if the "traditional" companies (that do not use 4.0 technologies and do not plan future interventions) still represent the great majority of the industrial population, it is clear that we are facing a phase of change, where the new technologies give the chance to the companies to benefit of an higher level of connectivity that they can use in order to guarantee a positive and complete customer experience. Philip Kotler – in his book *Marketing 4.0 (2017)* – shows some practical examples of how the 4.0 technologies can have an important impact on the customer experience, in particular related to the practices of *showrooming* and *webrooming*.

It is called *showrooming* the scenario in which a customer discovers a specific product through a television advertising, he decides to test the product within the closer shop and, ended the "experience" in the shop, he opt for buying the product online at a lower price. Utilizing the Industry 4.0 technologies it is possible to bring showrooming into online channels; in order to do it some companies (e.g. Tesco, a South Korean firm) have decided to develop virtual stores in public place where customers can shop with their smartphone, scanning the products.

The *webrooming,* instead, represents the scenario in which a customer discovers a specific product through an online banner, he looks for additional information on the internet and then he decides to buy the product in a "physical" store. In this case, thanks to the *sensor technologies* of the Industry 4.0, it is possible to bring the webrooming into "offline" stores: "Retailers (e.g., Apple Store, GameStop, Macy's) can place beacons strategically throughout their stores. The beacons can communicate with customers' smartphones using Bluetooth technology, creating machine-to-machine connections, when they are in close proximity. Thus, beacons allow retailers to track where customers are located inside a store. Moreover, retailers can monitor which departments customers often visit and how much time they spend there. The beacons also trigger retailers to send customized offers to customers' smartphones based on the location." (Kotler et al., 2017, p.95)

The main instruments and machineries that could be taken into consideration among the world of the smart factory and the Industry 4.0 are the following:

- *Robotics*: it includes classic industrial robots, operational robotics and "smart" systems capable of adapting activities to the processes. In general terms, it is possible to define robotics as the discipline that studies and develops methods that allow a robot to perform specific tasks by reproducing, and very often simplifying, human work.
- *Additive manufacturing*: such as 3D printing and stereolithography. The stereolithography is a technique that aims to create - starting directly from digital data processed by a CAD / CAM software – three-dimensional objects. Generally speaking, it is possible to define the additive manufacturing as an unification process of several layers of material, with the aim of manufacturing products with a 3D shape. This technique could be considered as the opposite process of the so called "subtractive production".
- *Laser cutting*: laser cutting is a technology that uses a laser to cut materials, and it is typically used in industrial production. Laser cutting operates by directing the output of a high-power laser through a lens. Industrial laser cutting is often used to cut flat sheet materials as well as structural materials.
- *Data collection and data processing systems*: These include *Big Data* and *Cloud*. The term Big data is used to describe a very complex and extensive collection of data, which occurs quickly and with great variety; due to this, therefore, it is necessary to use specific technologies and analytical methods to extract useful information from companies. The Cloud is a computer system with a key feature: the ability to process,

transmit and store data, making them available for consultation whenever it is necessary, using the internet connection.

- *The 3D Scanner* is a useful scanning tool to evaluate information and data on a specific object. At the base of this instrument there is a laser sensor, which has the purpose of measuring the distance between a surface and the instrument itself, timing the return flow of the emitted luminous flux with great precision.
- The term *augmented reality* is used to indicate tools and machinery that allow man to "expand" the perceivable reality through the five senses, adding virtual sensory information.
- *Internet of Things*: in general terms, the IoT represents every tool that can have an Internet connection and that is able to transmit data and information to the net.

The *Artificial Intelligence* is part of the Industry 4.0 universe but, while the use of the aforementioned innovative tools is becoming widespread among the Italian manufacturing companies, such advanced technology as Artificial Intelligence is mainly applied only in those that can be defined as pioneering innovation companies.

1.3 Definition of *Artificial Intelligence*.

The specialized site *AI4Business* defines, in a simplified way, the Artificial Intelligence as “the ability of a technological system to solve problems or perform tasks and activities typical of the mind and human abilities. Looking at the IT sector, we could identify AI - Artificial Intelligence as the discipline that deals with realizing machines (hardware and software) able to "act" independently (solve problems, perform actions, etc.)” [3].

The Artificial Intelligence was born in the middle of the twentieth century but, only in the last years, its role has grown importance in industrial production and within the management team of a company.

1.3.1 Weak and Strong AI

In order to better understand what the Artificial Intelligence is, it is important to make a distinction between the two main types of AI, that are:

[3] https://www.ai4business.it/intelligenza-artificiale/intelligenza-artificiale-cose/

- *Weak Artificial Intelligence:* it represents technological systems capable of simulating some human cognitive functions without reaching the real intellectual abilities typical of human; these are mathematical problem-solving programs through which it is possible to develop functionalities for solving problems or for allowing machines to take decisions. A practical example of *weak ai* are: Siri (the Apple digital assistant) and Alexa (personal assistant made by Amazon).

- *Strong Artificial Intelligence:* it represents technological systems defined as "wise systems" (or "self-conscious" systems) due to the fact that they can develop their own intelligence autonomously without emulating thought processes or cognitive abilities similar to human. *Strong ai* "[…] does not classify, but uses clustering and association to process data. In short, it means there isn't a set answer to your keywords. The function will mimic the result, but in this case, we aren't certain of the result. Robotics and automation are becoming more popular in the home and factory. These tools respond a certain way when given an input. […] You want your robots to listen to you (i.e., obey). AI might sound convenient, but advanced algorithms with supervision are, for now, what homes and production lines should have" [4].

The Strong Artificial Intelligence if, from a hand, seems to be more innovative and useful then the Weak one, from the other hand it is riskier and more uncertain. In fact, implementing an autonomous "strong" ai within a corporation can lead the management team to take wrong decisions, due to the absence of human abilities' emulation.

1.3.2 Four main functional levels of AI

Once made the distinction between *strong and weak ai*, it is necessary to describe how the Artificial Intelligence works. Nicoletta Boldrini (2018), in her work *AI- Artificial Intelligence*, defines the four main functional levels of *ai*:

- *Comprehension:* through the simulation of cognitive capabilities of data and event correlation, the AI is able to recognize and extract information from images, audio, tables, graphs and scripts.

[4] https://www.machinedesign.com/robotics/what-s-difference-between-weak-and-strong-ai

- *Reasoning:* through mathematical algorithms the AI systems are able to interrelate all the information gathered.

- *Learning:* at this level, the AI systems analyze the input gathered in order to return the proper output. In this phase the AI learns and develops its main functionalities through automatic learning techniques.

- *Human Machine Interaction:* it refers to the AI operating mode in relation to its interaction with human. At this level, *Natural Language Processing (Nlp)* are becoming more relevant. *Nlp* are technologies that allow humans to interact with machineries and vice versa.

On the way along these levels, the **relationship between the Artificial Intelligence and the Internet of Things (IoT)** plays a key role. This relationship can be compared to the one between the brain and the human body: the human body uses a lot of sensory inputs (such as sight, hearing and touch) and, thanks to these, it is able to recognize specific situations and to act accordingly. Our brain, based on sensory input, makes decisions, sending signals to the body to control the relative movements. The *IoT* could be considered as a set of connected sensors, and thanks to *Artificial Intelligence* it is possible to make sense of all the data acquired and, consequently, decisions can be made and the "movements" of the various machines can be activate.

In order to execute and to carry out the Artificial Intelligence within an organization, it is fundamental to have access to a very high number of data; for this reason, every company needs to be able to perform *data collection* and to implement *data processing systems.* The Big Data analysis is strictly related to the Artificial Intelligence application; without data there is no chance to implement an Artificial Intelligence algorithm.

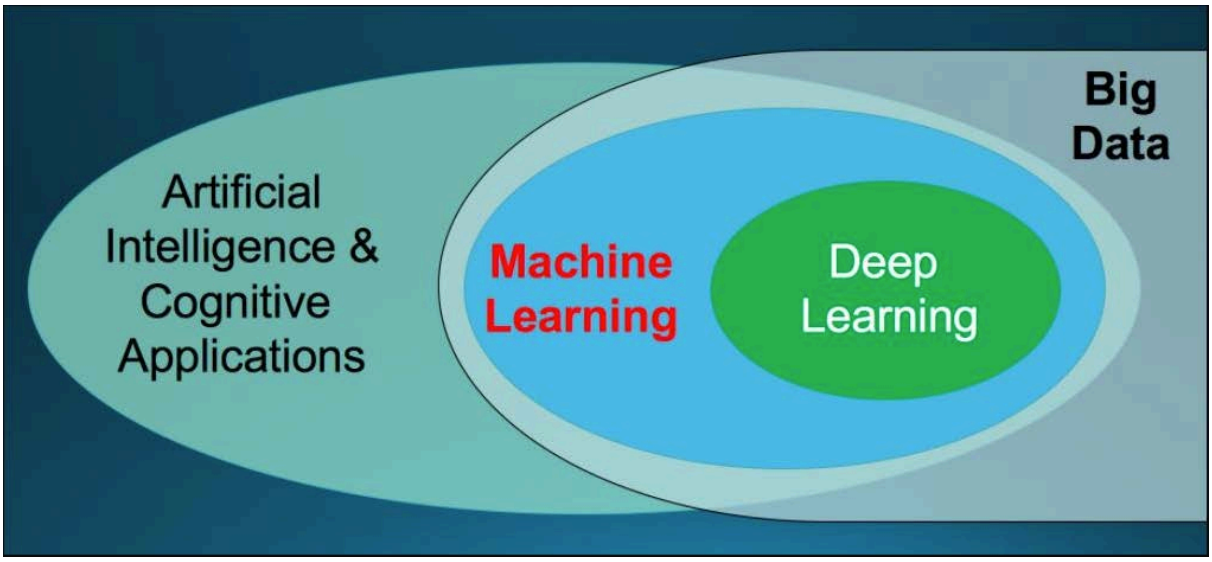
1.3.3 Machine Learning and Deep Learning

Within the environment that involves the Big Data and the Artificial Intelligence, the specialized site *Innovationpost.it*[5] defines two critical concepts in which it is necessary to focus, that are: *Machine Learning* and *Deep Learning*.

The *Machine Learning (ML)* is essentially a way to implement Artificial Intelligence. Sometimes the terms AI and machine learning have been used interchangeably, but it is more

[5] https://www.innovationpost.it/2018/02/14/intelligenza-artificiale-deep-learning-e-machine-learning-quali-sono-le-differenze/

appropriate to define the ML as a kind of AI subgroup, that focuses on the ability of machines to receive a set of data and to improve themselves autonomously, modifying algorithms when they receive more information on what they are processing. The machine learning could be considered as a way to teach to an algorithm how it has to work; in doing this, it is necessary an enormous amount of data, in order to give to the AI the "adaptation abilities" needed to face different scenarios that may occur. In conclusion, it is possible to affirm that machine learning is the ability to perfectly perform new tasks, based on known properties derived from experience and from the analysis of historical data based on forecasts (Ismail, 2015).



Source: https://www.innovationpost.it/wp-content/uploads/2018/02/big-data.jpg

The *Deep Learning* could be considered as a subcategory of the Machine Learning, that includes applications like image and speech recognition.
It learns complex models through a huge amount of data, taking advantage of computational progress and training techniques. The most interesting aspect of the Deep Learning is that it allows a machine to discover new schemas, which could become "standard", without being trained or being exposed to historical data.

1.4 *Artificial Intelligence*: Business Intelligence and Data Management.

The way in which a company gathers, organizes, analyzes and manages the data is crucial in order to have the best application of Artificial Intelligence in a corporation.
A proper *data management* represents the starting point for the implementation of the AI.

All the data that are not properly organized and analyzed risk to be unusable for the company: this would lead to the caveat “garbage in, garbage out”. This sentence summarizes in few words the following concept: if a company inserts flawed input data in its algorithms and technologies, the only possible result will be a “garbage” output.

1.4.1 From Data to Knowledge

“With the increase of business analytics (BA) the caveat “garbage in, garbage out” is more apt today than ever before. The proliferation of data has made it more imperative to pay attention to data before you attempt analytics. Because few analytics projects today are done with a single data type or source, there are questions about how data characteristics would affect the way data is to be integrated and used. To distinguish many new and less-structured data from conventional data stored in database, data-warehoused, […] the industry has coined a new term: Big Data” (Lin 2015, p.21).

Nathaniel Lin - in his book *Applied Business Analytics: Integrating Business Process, Big Data, and Advanced Analytics (2015)* - defines the Big Data as data that are too complex to be analyzed by standard relational database management systems (RDBMS) and that hold at least one of these “V” attributes:

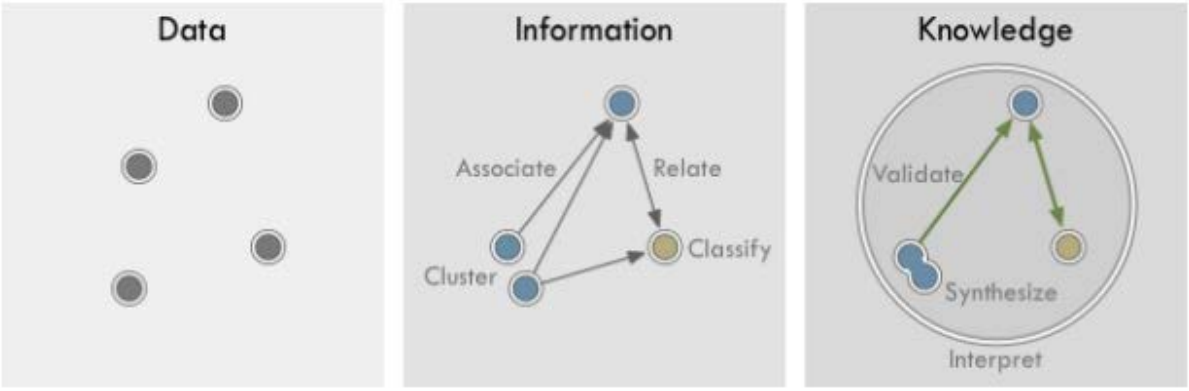
Velocity: the speed to generate, analyze and manage the data is faster than the speed of the company’s technology in dealing with the data.
Volume: the amount of data that the company has to manage is huge and there is the risk to exceed the storage capacity of the company’s databases.
Variety: the data come from different sources and have different kind of formats.

To these “V” attributes it is possible to add a fourth V: the *veracity*; it represents the low level of clarity in the data that are part of the “Big Data world”.
Given the large quantity of data that every company has to face every day, it is important to underline the fact that not all the data are valuable; in fact, not all the data become automatically knowledge for the company.
A distinction that, at this point, it is crucial to make is the one among *data, information* and *knowledge*:

Data can be considered as information collected in raw or unorganized form (such as alphabet letters, numbers, or attributes) that refer to requirements, concepts, or purposes.

Information represent "Data that is (1) accurate and timely, (2) specific and organized for a purpose, (3) presented within a context that gives it meaning and relevance, and (4) can lead to an increase in understanding and decrease in uncertainty" [6]

Knowledge is the result of information interpretation. Once the decision-maker is able to understand the data, he uses the information at his disposal, his experience, and his personal interpretation in order to transform the data into knowledge. In conclusion, the knowledge can be considered as the transformation of information in value.



Source: https://advancedmarketingunipd.files.wordpress.com/2014/09/4-market-research.pdf

Andrew NG, computer scientists and co-founder of the *Google Brain*, pointed out – in his paper called *AI Transformation Playbook* (2018) - the key role of data in an AI system.

The three main pillars, regarding data collection and management, on which the strategy of a company that wants to implement Artificial Intelligence must rest, are:

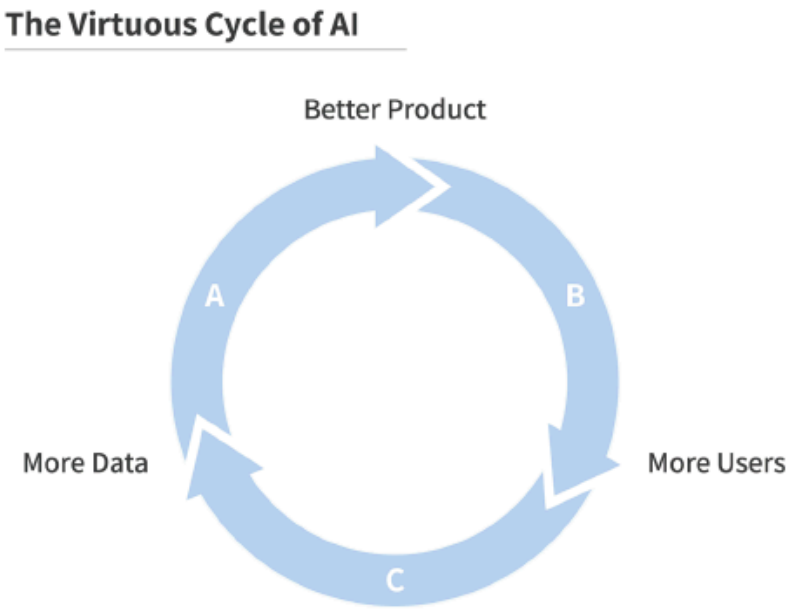
Strategic data acquisition. Useful AI algorithms can be built using both small and big data. Obviously, if the company is able to cope with a large amount of data, the more data you have, the more Artificial Intelligence will be reliable, as it will have the opportunity to deal with a greater number of scenarios. In order to collect more data, companies like Google and Baidu continue to offer products that do not monetize but allow them to acquire data that can be crucial for the company success.

Unified data warehouses. In order to leave the chance to the AI system to work taking into account the data of the whole company, the best thing to do is to centralize the data into a small

[6] http://www.businessdictionary.com/definition/information.html

number of data warehouses. In this way it will be also simpler for every employees and decision maker to search and find the data needed.

Recognize what data creates value for the company. It is not easy for an AI team to cope with billions of data and, as defined previously, some data could be merely "garbage". Make a correct selection of the data to be used as input for the AI algorithms is essential for the success of the whole AI project.



Source: Andrew NG (2018)

1.4.2 The role of Business Intelligence

Minella and Rolle (2010) point out the fundamental role of the Business Intelligence function within a firm. Business Intelligence (BI) is a strategic tool, fundamental to integrate business processes, to take full advantage of the value of data available in the company, to support management, to develop forecasts and simulations. BI makes analysis that allow the company to be present on the market effectively; in particular, it help the management to anticipate and respond effectively to the needs of its customers, improving their level of satisfaction. BI also seeks to identify key aspects that may affect the market in the future in a timely manner.

The application of Business Intelligence (Minella and Rolle 2010, p.11) helps to:

- optimize management decisions;
- align tactics with strategy;
- identify challenging goals and ways to achieve them.

Business Intelligence includes the collection, integration, analysis, interpretation and presentation of business information.

The classic *Management Information Systems (MIS)* process the structural data in a limited way, providing standardized reports. Business Intelligence instead uses *Executive Information Systems (EIS)*, aimed at supporting the decision-making needs of top managers, providing easy access to key internal and external information.

Furthermore, the *Business Performance Management (BPM)* is a tool used to optimize business results through effective feedback cycles, improving processes by monitoring KPIs (key performance indicators) or KSIs (key success indicators).

The Business intelligence differs from the simpler *Knowledge Management* (showed previously) for the following aspects:

<table>
<tr><td>ACTION</td><td rowspan="4">BUSINESS INTELLIGENCE</td></tr>
<tr><td>DECISION-MAKING</td></tr>
<tr><td>SKILLFUL INTELLIGENCE</td></tr>
<tr><td>INTELLIGENCE</td></tr>
<tr><td>KNOWLEDGE</td><td rowspan="3">KNOWLEDGE MANAGEMENT</td></tr>
<tr><td>INFORMATION</td></tr>
<tr><td>DATA</td></tr>
</table>

Source: Minella and Rolle (2010), p.12

1.4.3 The role of Marketing Intelligence

The previous paragraphs show the central role of Data in the implementation of AI; it is fundamental a correct management of data also for what concern the marketing area, in particular through the *Marketing Intelligence System*.

Kotler and Keller in their work called *Marketing Management (2016)* defines a Marketing Intelligence System as a set of procedures that managers use in order to obtain everyday information about developments in the marketing environment.
The main difference between the *Internal Record System* and the *MIS* is related to the fact that the former provides "results data" and the latter provides "happening data" (data in continuous evolution).
The Internal Record System is composed of:

- *the order of payment cycle*: it is fundamental in order to manage the whole payment cycle that involves customers, dealers and sales representatives
- *the sales information system*: measure the current sales in a timely and accurate manner.
- *databases:* set of information recorded in a mass memory, managed by a specific program and structured in order to facilitate consultation.
- *data warehousing:* aggregation of structured data coming from internal operational sources and external to the company information system, useful for analysis and reporting.
- *data-mining:* set of techniques and methodologies to extract useful information from large amounts of data for business or operational purpose.

Nowadays the companies have the chance to collect a lot of marketing intelligence data on the internet, and this simplify a lot the marketers' job. The data could be collected in: customers forums, distributors feedback sites, sites offering customers reviews and expert opinions, customers complaint sites and blogs. Once all the data are collected and converted into information, the marketing intelligence function has to work in coordination and relation with the decision-making processes (Kotler and Keller 2016, p.94).

1.5 Baseline for the implementation of *Artificial Intelligence* in a corporation.

The specialized site *Digital4.biz* shows, in its article of 18 January 2019, that today the 70% of the "effort" related to an AI project is for *process redesign*, 10% for *algorithm writing* and only 10% for the *technological implementation* [7].
According to data from the *Politecnico di Milano*, 56% of large Italian companies have already started projects of Artificial Intelligence, even if they are still in their "basic initial phase".

[7] https://www.digital4.biz/executive/ai-cos-e-l-intelligenza-artificiale-e-come-puo-aiutare-le-imprese/

Comparing the behavior of Italian companies with European ones, it should be noted that the number of projects started is lower: 56% in Italy against 70% in France and Germany.
The most advanced sectors in the application of Artificial Intelligence projects are: banks, logistic, finance and insurance, automotive, energy industry and telecommunications companies.
The implementation of AI within a corporation is not an easy task. The web-site *PMI.it* has provided a report made by the "Artificial Intelligence Observatory" of the Politecnico di Milano, which shows a series of useful tips for introducing AI technologies to the company [8].

- The first step to be taken, generically common to almost every type of project to be implemented, is the definition of the *objectives to be achieved*, with all the internal and external implications.

- The second phase involves the *selection of the data sources* necessary for the functioning of the Artificial Intelligence model. In this phase and in the following ones is crucial the revision and validation of data, with a particular focus in their relationship and coherence. The reliability of the data sources is fundamental for the correct implementation of the AI technologies.

- The AI model needs a solid base to lean on. In fact, the third step suggested is the *selection of the hardware* on which the model is based, as well as all the devices that ensure proper integration with the company's environment.

- the phase of *customization* of the Artificial Intelligence model is based on the training and testing of the AI algorithm.
- Once the AI model is correctly customized, it needs to be *integrated* and *adapted* to the technologies that are already part of the company.

- The AI algorithm needs a constant *monitoring* system, in order to check the validity and the reliability of the model based on the new data gathered.

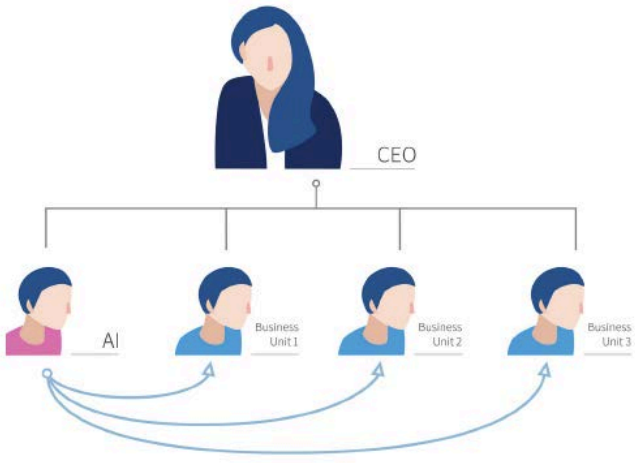
Others fundamental tips for the implementation of AI projects within an enterprise are provided by Andrew NG (which has already been mentioned in paragraph 1.4.1), considered one of the

[8] https://www.pmi.it/tecnologia/infrastrutture-it/300431/come-introdurre-lia-in-azienda.html

main global leader in Artificial Intelligence. He worked in Google playing a crucial role in developing the *Google Brain* and, currently, he works for *Baidu*, a Chinese multinational technology company specialized in Artificial Intelligence.

In his work called *AI Transformation Playbook (2018)*, Andrew NG suggests some steps to follow in order to implement AI:

1. *Develop a pilot project in order to gain "momentum"*. The first time that a company decides to implement an AI project, the success of this is fundamental; the creation of value will come later. In fact, at the beginning, what matters the most is the "positive company environment" that have to drive the project. This should create the right level of strength and awareness that works as a base for the future project development. In developing the "pilot project", the company could ask the help of an experienced external AI team in order to limit the risk of failure in the early stages.
2. *Build an internal AI team.* The role of an experienced external AI team is important in order to increase the chances of success at the very beginning; in the long term, it is better for the company to build an internal AI team that should be capable to increase the efficiency and effectiveness of the whole project. "In the AI era, a key moment for many companies will again be the formation of a centralized AI team that can help the whole company. This AI team could sit under the CTO, CIO, or CDO (Chief Data Officer or Chief Digital Officer) function if they have the right skillset. It could also be led by a dedicated CAIO (Chief AI Officer). […] Many companies are organized with multiple business units reporting to the CEO. With a new AI unit, you'll be able to matrix in AI talent to the different divisions to drive cross-functional projects." *(Andrew NG 2018, p. 3-4*)



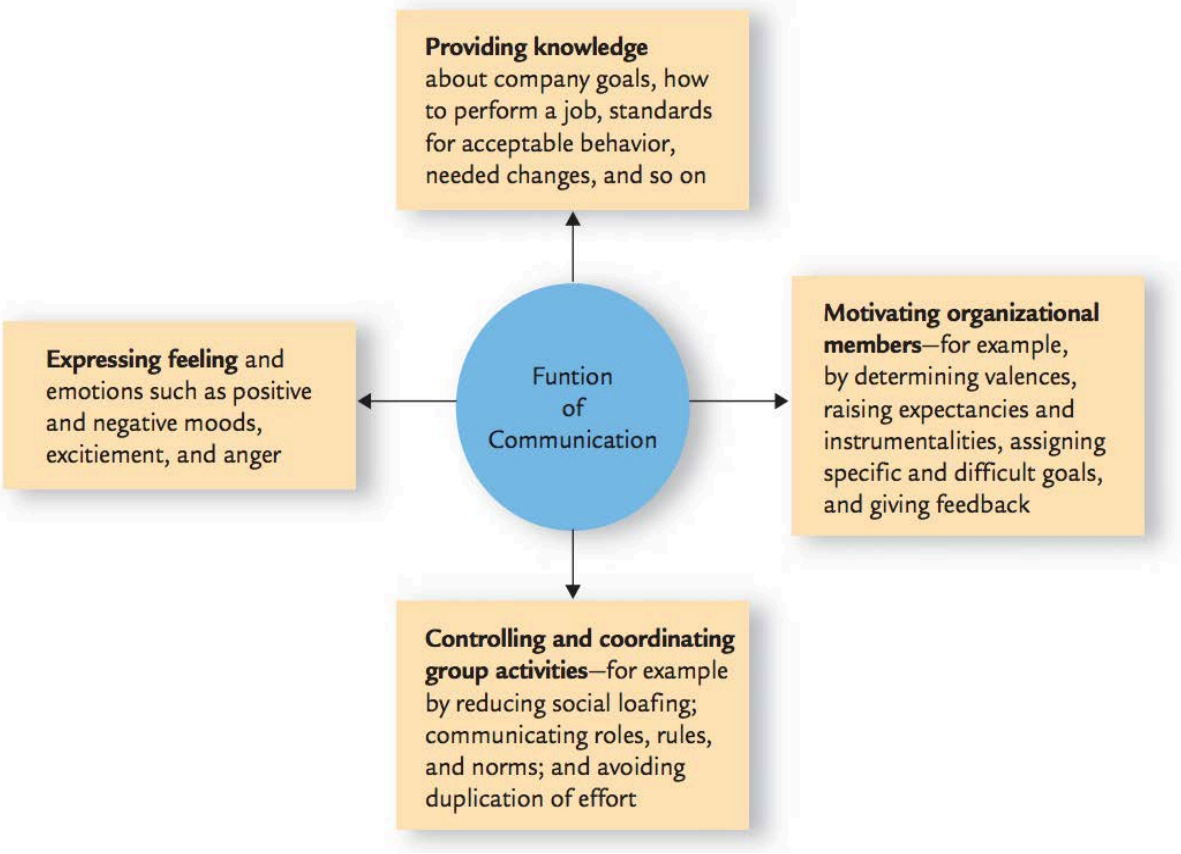
Source: Andrew NG (2018, p. 4)

3. *Provide broad AI training*. According to Andrew NG, one of the best method to follow in order to provide a broad AI training is the so called *"flipped classroom"*. This method is revolutionary as it combines the on-line learning with the learning on the job (learning by doing). "In the *flipped classroom*, students are required to engage in or complete some form of preliminary learning online in preparation for a structurally aligned learning activity on campus with their instructors and peers. […] In flipped mode, students will be meeting a topic for the first time online usually via short and to the point videos, rather than through attending a lecture as has been traditionally the case." *(Reidsema et al, 2017).* The main aim of this method, applied in the working environment, is to improve the participation of employees during the training.
   Concerning the AI training, the most of training hours have to be dedicated to the training of AI engineers, because they are those who have to practically develop the AI projects.

4. *Develop an AI strategy.* It is wrong to consider the actualization of an AI strategy as the first step to follow. At the early stages, the company has not enough capabilities and knowledge concerning the "AI world", and this is the main reason why it is better to realize a baseline of AI knowhow through the "pilot project" instead to start developing directly an AI strategy. The pilot project, the development of an internal AI team and the AI training are all crucial steps to follow in order to develop rightly an AI strategy.

5. *Strengthen internal and external communications*. In case of important change within a company, the communication is the key for success. It is crucial to communicate the change internally and externally, because it could affect different stakeholders. In fact, for example, the application of AI in the supply chain needs a coordination with the company suppliers that have to be informed. The communication has to: *provide knowledge, control and coordinate group activities, motivate the organizational members* and *express feelings*.

   The four main functions of the communication are showed in the following table:



Source: https://elearning.unipd.it/economia/pluginfile.php/62497/mod_resource/content/0/OB_2018_07_Communication.pdf

Performing an effective communication is not an easy task, particularly for an innovative topic as Artificial Intelligence; in fact there are some "barriers" that can increase the difficulties that a company may face during the communication process, such as:

- *differences in cross-cultural linguistic styles;*
- *lack of inappropriate feedback* (senders fail to provide feedback)*;*
- *poor listening;*
- *workforce diversity;*
- *information distortion* (the change in meaning that occurs when a message go through a series of different senders to a receiver).

All the previous steps can be considered as a starting point for the implementation of an AI project within an enterprise.

CHAPTER 2:

Application of Artificial Intelligence in corporations.

2.1 Approaches to AI introduction

The author Alessandro Giaume (2018) defines that it is wrong to stick the label of "*disruptive*" to a transformation that is justifiable if applied to completely digitizable products (like books , music or e-commerce) but it is not adherent if applied to complex products such as household appliances or automatic machines, whose use occurs in a physical dimension. For the transformation of these processes it is more correct to speak of *incremental introduction*, characterized by a continuous improvement concept. After an initial phase of *hype*, the subsequent practical applications lead to the most profitable and interesting phase, during which the experience gained on technology finally opens the conditions for its stable and lasting industrial use. The continuous improvement concept represents the basis of the Lean Production; every company that wants to grow has to follow this approach.

2.1.1 Continuous Improvement Approach

As explained by Womack and Jones in their book called *Lean Thinking* (2003), the Lean Production is based on five principles:

- *Defining value*: the company has to understand what matters from a customer point of view.
- *Mapping value*: the company has to map all the activities needed in the production and information process.
- *Flow:* the company has to put each activity closer to the following one, in order to reach the one piece flow logic.
- *Pull:* the company has to run the production on the base of the demand, producing only what is needed and avoiding to build up inventory.
- *Perfection*: the company has to improve continuously in order to reach the perfection.

The main difference between the continuous improvement and the breakthrough improvement approach is principally related to the “time schedule” of the improvements.

A company that decides to implement strong and unexpected changes within its business, presenting improvement projects without particular notice and without a proper preparation and communication, it is following a *breakthrough improvement approach*.
On the other hand, a company that introduces changes and projects of growth in a gradual manner, with a correct preparation and communication - thus avoiding creating excessive turmoil within its own workforce - it is following a *continuous improvement approach*.
These two different approaches "open" a trade-off between the risk to be faced and the time spent. The breakthrough improvement approach, in fact, is riskier than the continuous one, but it is less time consuming.
Even the introduction of the Artificial Intelligence within the corporation puts a company in front of this trade off.
In fact, a company that decides to implement the Artificial Intelligence without a correct preparation and communication obviously will save time but, simultaneously the risk to face a failure will increase. As every huge change within the corporation, the implementation of the Artificial Intelligence should follow the so called *"Kotter's Model"*. It is a "popular model for planning, implementing and sustaining change […]. The Kotter's Model breaks down the organizational change process into eight steps […] that offer a simple, straightforward guidance for change planning." (Sabri et al 2007, p. 176).

2.1.2 Kotter's Model Application to AI

All this considered, it could be helpful for a company that is going to introduce an AI technology to follow the steps of the "Kotter's model" (Sabri et al, 2007):

● *Step 1*- Create a Sense of Urgency: show to the employees the fact that the implementation of AI is needed and the future opportunities that the company will reach. Try to communicate information broadly and clearly.
● *Step 2*- Build the Guiding Team: create a group of 3-5 individuals that feel great urgency and that are able to influence the others. Better if these workers have formal authority and leadership skills.
● *Step 3&4*- Create and Communicate Your Change in Vision: also through nonverbal communication (e.g. picture and posters). Show to the workers the possible opportunities that they could exploit if the implementation of AI will be successful.
● *Step 5*- Empowering Broad-Based Action: try to create a group involving the workers and

blue collars that were able to overcome successfully a prior change process (e.g. the introduction of Industry 4.0 technologies) in order to influence and "pull" the others.

● *Step 6*- Celebrate the Short Term Wins: once the AI implementation process starts, celebrate the short term wins; it is wrong to wait too much before showing to the workers the results of the change.

● *Step 7*- Reinforce the Change: Use increased credibility to change systems, structures and policies that do not fit. Recognize and reward employees involved in the improvement that show very high level of commitment and effort.

● *Step 8*- Institutionalizing New Approaches: tell vivid stories over and over about the potentiality of the AI algorithms, with a particular focus on what it does and why it succeeds.

The introduction of an advanced technology such as Artificial Intelligence always requires correct communication at all company levels, but primarily aimed at blue collars, which can be considered as the corporate category that could accept this change with more difficulties.
Blue collars are those which fear that their work can be replaced by software related to Artificial Intelligence, but this does not always happen, because, as will be seen later in the results of the qualitative research, the role of the individual continues to be crucial in the application of this technology.

2.1.3 PDCA Cycle

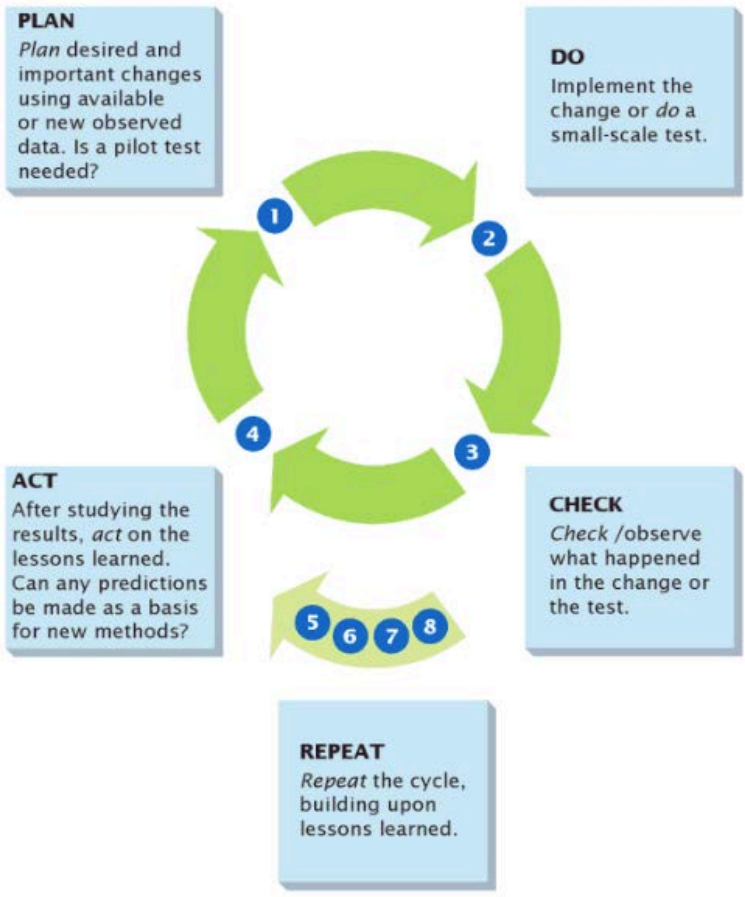
As seen in the *paragraph 2.1.1*, the *continuous improvement* is the goal that every company tries to achieve every day, but for lots of them it remains an abstract concept.
In practice, to achieve a continuous level of improvement, the perfect AI project manager should put in place a plan to follow, in order to evaluate and implement the actions to carry out for the resolution of problems.
A scientific approach to problem solving - which can also be applied to Artificial Intelligence projects - is the *Deming or PDCA cycle* (Plan-Do-Check-Act).

The PDCA cycle has been developed in the 1950s by William Edwards Deming; it is an approach to problem solving that allows the project managers to test various possible problems solutions in order to identify the most effective one, prior to opt for the final implementation. In particular, it is structured as a method to identify why a process does not meet expectations, developing hypotheses about possible changes and testing their effectiveness in a continuous loop *(Nagao, 2019).*

The Deming cycle is based on 4 successive steps and it is a systematically improved and repeatable model for process optimization and improvement of quality and efficiency.

The *PDCA cycle* consists of:

- *Plan* - Identification and analysis of the problem or new opportunity, development of hypotheses on when potential problems may arise.
  Establish the processes necessary to provide solutions in accordance with the expected results. When possible, start on a small scale, to check the possible effects.
- *Do* - Test the potential solution, ideally on a short scale, and measure the results. Collect data for the creation of graphs and analyzes that could be useful to the "Check" and "Act" phase.
- *Check* - Study the results, measure their effectiveness and decide if it is possible to support the analyzed hypothesis. Analyze the results collected in the "Do" phase, comparing them with the expected results –which are the objectives of the "Plan"- to verify any differences.
- *Act* - If the solution works, implement it.



Source: Kreitner, 2019, p. 482

The PDCA cycle can also be implemented in projects concerning the introduction of Artificial Intelligence in the company.

It is therefore necessary to start with the "Plan" phase, where the aim of the AI project manager should be the one of finding the countermeasure to the potential problems that could arise with this new technology.

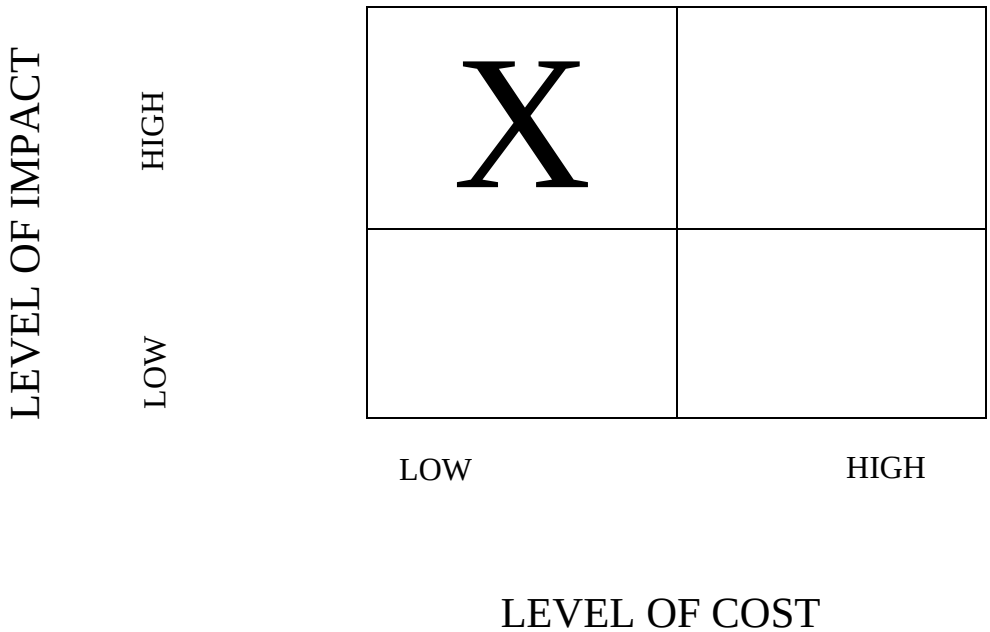
In this first phase it is more correct to talk about countermeasures and not solutions. Countermeasures represent something that could be changed and substitute in the future; the solutions, instead, represents something that is definitive within the company.

The “Plan” phase is the more time spending one, in fact it takes almost the 80% of the overall Deming cycle to be completed.

In the “Do” phase the AI project manager has to start implementing the most important countermeasure for his company.

In order to discover which is the most relevant countermeasure, the AI project manager has to analyze the level of impact and cost of every countermeasure at his disposal; then he/she has to choose the countermeasure that guarantee the highest level of impact at the lowest cost (as shown in the *Table 1*).

Table 1.



Once the AI project manager has identified the best countermeasure, the "Check" phase can start.
This phase end only when the AI project manager is sure to be able to achieve the results that the company wants to achieve.
In the case in which the "Check" phase fails and it is not possible to reach the results aimed, the AI project managers has to go back in the "Do" phase and he/she has to try another countermeasure.
In the last stage, represented by the "Act" phase, the countermeasure that guarantees to reach the aimed results is standardized.

2.2 AI applications in Marketing

Within a company, the application areas of Artificial Intelligence are numerous and goes from *marketing* to *operations management*.
Starting from the *marketing* area, it is necessary to underline the fact that Artificial Intelligence tools are fundamental in order to *customize the offers* and "to lead" customers to take the correct decision. In particular, AI tools can allow marketers to deliver ad hoc projects based on user preferences with more targeted and effective messages.

The *Artificial Intelligence Marketing (AIM)* is a new discipline born in recent years, that can be considered as a branch of Marketing that exploits the most modern technologies that fall within the field of Artificial Intelligence (such as Machine Learning and Natural Language Processing), integrated with mathematical/statistical techniques and behavioral Marketing.
The AIM uses Artificial Intelligence and Machine Learning algorithms with the aim to persuade people to perform an action, buying a product or access a service (in other words, respond to a "call to action") [9].
The web-site *Econsultancy* [10] describes the main **AI application in marketing**:

- *Product recommendations*: this application is crucial for companies that offer a broad portfolio of products to their customers. AI algorithms, after an in-depth analysis of the data collected, are able to help the company in defining which are the customized offer to make to each specific customer. To do this, the AI algorithm explore all the previous

[9] https://www.ai4business.it/intelligenza-artificiale/intelligenza-artificiale-cose/
[10] https://econsultancy.com/15-examples-of-artificial-intelligence-in-marketing/

choice of the customer (or, in e-commerce, the time spent in watching a specific product) in order to offer a product compatible to the customer's behavior and client's preference. The most famous example in this field are: Netflix (that suggest new films and TV series to its customers), Spotify (that suggest new songs to its clients) and Amazon (that suggest new products to its consumers).

- *Data filtering*. Every company has to face millions of data every day. A human cannot analyze all the data by discerning those useful to the company from those to be discarded; it is at this stage that Artificial Intelligence comes into play, simplifying the work of the employee.

- *Visual search:* "it can be used to improve merchandising and personalize the shopping experience: instead of recommending products based on a shopper's past behavior or purchases, visual search technology can recommend relevant products based on how they look, helping shoppers to find items of a similar or complementary style." [11].

- *Social listening:* it refers to the process, done by a corporation, of inspecting what the people (and mainly the clients) said about a product or a brand on the social media and on internet in general. Without an advanced AI algorithm it would not be possible to correctly analyze and check what people think about your brand. In fact the consumers are used to said what they really think to their peers, and not to the marketers. Thanks to the social listening, Samsung discovered the Galaxy S8 issues.

- *Product pricing:* defining the correct price is a key aspect for every company. Artificial Intelligence algorithms, taking a broad variety of data into account, are supposed to improve the level of precision and reliability of the charged price.
  The greatest utility of Artificial Intelligence concerns the application of dynamic pricing policies, which are based on the analyses of the client's data with the aim of defining their willingness to pay.
  "The key inputs to determining price are grouped based on their fluctuations over time. This becomes a smart way to group the variables as the ability of an algorithm to learn and use price changes with the kind of variables used. Fast time-scale (rapidly changing) data includes: daily weather, category average price, competitor price, consumer

[11] https://econsultancy.com/15-examples-of-artificial-intelligence-in-marketing/

propensity to buy, […] seasonality, currency fluctuation, […] perceived wait time to receive the product […]. Pricing algorithms would differ based on whether it is a new product being introduced, a variation of an existing product or just an existing product being dynamically repriced." (Pradeep et al, 2019)

AI algorithms can help the companies on targeting better their clients, defining "customize" and ad-hoc price for each of them, determining if there is the need of a discount to push them to complete the purchase.

- *Predictive analytics:* "This is the process of using data mining, statistics and modelling to make predictions about future outcomes. In other words, historical data defines a set of parameters, which computers can then use to determine what user behavior/responses might be in the future." [12].

  Artificial Intelligence algorithms can analyze datasets and create "predictive model" through such analysis. This could lead to a positive impact in the managers' decision making process; in fact, thanks to these new models (generated by AI), managers have further information to make their choices. In particular, concerning the e-commerce, the application of AI in predictive analytics can be useful in order to have a clearer idea of customers' purchase behavior (based on the customers past actions) for the determination of their future purchase.

  Hence, Artificial Intelligence could determine which are the managers' "winning strategies" and anticipate which will be the volumes of products required by the customers in the future.

- *Dynamic targeting and segmentation:* it is a process based on real time data that considers the consumers' needs and preferences as not static; as a consequence, the targeting and segmentation proceedings have to reflect this aspect, considering each customer segments as variable. In doing this, the application of AI tools is crucial.

  "For example, if a young person browses for a gift for an older relative, dynamic segmentation will group them in with the segment most appropriate to their current buying behavior using real-time data, presenting the most relevant offers and avoiding using outdated data for targeting." [13].

[12] https://bigdata-madesimple.com/innovations-and-trends-how-ai-is-improving-predictive-analytics/
[13] https://econsultancy.com/15-examples-of-artificial-intelligence-in-marketing/

- *Programmatic AD targeting.* Utilize AI algorithms could be useful to schedule the online advertising of a company. In fact, the marketers can exploit the AI to define which is the right moment to post an AD banner, in order to have the highest possible conversion rate (defined as the percentage of visitors who have performed the specific action that an advertiser defined as the campaign's goal).

- *Sales forecasting.* The analysis of data through Artificial Intelligence can help the managers on projecting the future demand and, as a consequence, improve the marketing plan.

- *Chat-bot.* Semi-automated or fully automated agents known as *bots* are radically changing the communication with customers, as a consequence of the development and implementation of Artificial Intelligence, Natural Language Processing and Machine Learning. Eduardo Freitas (2017) defines a *bot* as a portion of software that uses Weak Artificial Intelligence to perform specific tasks in place of a human. In particular, *chat-bots* are "robot programs" able to interface with users and carry out operations independently; for this reason they are increasingly widespread in the sales, marketing and customer service departments. One of the main purpose of a chat-bot is to answer to the millions of queries that every company receive from its customers, avoiding that the social media managers' assistants have to spend the majority of their working-time in doing this task.

- *Speech recognition:* it can be defined as the process by which "human oral language" is recognized and subsequently processed through an Artificial Intelligence system which acts as *voice recognition system*. Speech recognition systems could be applied in automatic call centers (in order to speed up the customers information research process), in "dictation systems" (which allow you to dictate computer speeches), or to control the Global Positioning Systems (GPS) within the car. The speech recognition systems can play a crucial role in removing the barriers of human-to-human communications and to improve the human-to-machine relation.

2.2.1 Affective computing

Regarding the relationship between emotions and Artificial Intelligence, John Wheller, managing director of CrowdEmotion (an Artificial Intelligence company with the aim to

improve the level of "emotionality" of AI software), stated that the computers, in order to be functional in our lives - as far as AI is concerned - must be able to understand or at least react to the human behavior and emotions [14].

The combination of AI software with empathy and emotional abilities could have a great impact and relevant implications for marketing activities, mainly related to the customer experience.

One of the main uses of Artificial Intelligence in marketing is linked to an analysis of actions such as clicks or purchases made, in order to make predictions about clicks or future purchases. Therefore, a significant amount of relevant information will not be taken into consideration by Artificial Intelligence if they are not able to read facial expressions, tone of voice or other important aspects of non-verbal language.

Thus, this technology, in order to be able to make truly accurate predictions of consumer behavior and to provide solutions and information, has to be able to recognize human emotions and respond consequently.

It is precisely in this field that, in recent years, a specific branch of Artificial Intelligence has been developing aimed to create computers capable of recognizing and expressing emotions: the so-called *Affective Computing* (Picard, 2000). The new frontiers of development of IT products aim at the implementation of affective machines that take into account the user's reaction to the system and that interact with it based on its emotional state.

Affective computing is a very broad field of study and can be divided into four dimensions:

- *Emotional Expression*: this dimension is interested in the creation of interface agents capable of reproducing emotional expressions, thus communicating emotions through, mainly, the representation of digital faces that imitate the salient features of human emotional expression. The purpose of this type of interface is not to provide the machine with emotion, but to attribute different emotions to different expressions;

Source: Paiva et al. 2007, p.10

[14] https://www.insidemarketing.it/emozioni-e-intelligenza-artificiale-implicazioni/

- *Emotional Recognition*: the purpose of these phase of affective computing is to recognize the emotional state of the user. Once done it, the machine has to adapt to the different emotional states in order to optimize the execution of tasks, in relation to the influence that the emotional state exerts on the human agent;

- *Emotional Manipulation*: this line of research is aimed at studying the ways in which it is possible to influence the emotional state of the user during the interaction phase with the machine. It is also called *affective interaction*;

- *Emotional Synthesis*: This represents the most complex dimension of the *Affective Computing*. The aim of this dimension is the one of equip a computer with emotional intelligence, thus making it able to "feel" emotions [15].

The fourth dimension, obliviously, has not yet been completely achieved, but the studies continue to proceed in this area. Success in this field could lead to a revolution in the world of marketing and customer relations.

2.3 AI applications in Human Resources

Many experts – as shown in an article of In-recruiting.com [16] of 14 March 2019 - agree that, in the following years, the workload of recruiters will increase exponentially.
On the other hand, the size of the recruiting teams is expected to remain unchanged or may be subject to contractions; however, with high probability, the size of recruiting teams will not increase proportionately with their workload.
This will mean that recruiters will be forced to "do more with less" and cope with considerable workloads. One of the most time-spending HR activities is, for example, the manual selection of CVs (mainly because, according to In-recruiting.com, almost the 88% of the candidates are not in line with the job position sought). Furthermore, it is estimated that the process that includes the CV screening and the selection of candidates, in order to establish an initial interview, requires at least 23 hours for the recruiter.

[15] https://www.ricercattiva.it/ricerca/puo-un-computer-diventare-come-noi-avere-stati-mentali-e-provare-emozioni-affective-computing/2/
[16] https://www.in-recruiting.com/it/intelligenza-artificiale-recruiting-guida/

The automation of long and repetitive tasks, like CV screening or interviews with candidates, could solve the aforementioned issues; this is where *Artificial Intelligence* could play a crucial role and make a significant contribution.
There are several activities that an Artificial Intelligence algorithm could allow to do, simplifying and improving the job of the recruiter:

- support the writing of job announcements;
- suggest similar candidates.
- optimize the search for candidates by keyword;
- automatically extrapolate data from a CV;
- use the semantic analysis (activity of assigning a meaning to a linguistic expression) in order to interpret the candidates' behaviors and actions; it allows the recruiters to create a cluster of candidates.

Utilize the Artificial Intelligence in the recruiting process can give the chance to the company to collect a lot of information concerning the candidates, even form their *social media profiles*. A possible future scenario could be the following: once the candidate has delivered his/her CV, the Artificial Intelligence could check whether the information provided is in line with what is showed in the candidate's social media profiles, with the aim of discovering any inconsistencies in the CVs. This type of process, at the moment, does not seem feasible since not all candidates could have detailed and updated social media profiles.

Barbara Van Pay, CEO of SmartHR Consultancy, in her article for Entrepreneur.com, said that:

"Given AI technology can efficiently source and screen multiple candidates in a short period of time the acceptance criteria set by the business and the candidate profile has to be matched to identify and match the most promising candidates for the job. Using this gathered data AI programs can then rank candidates on a scale using various pieces of information such as experience, work history, skill sets, and salary expectations to find the right person. This method of processing data is becoming highly valued in today's market because of its ability to locate passive candidates, who are generally the most desired, as they aren't actively looking for other positions and they are content with their current position meaning they are an asset to their company which in turn means there is less competition to place them." [17].

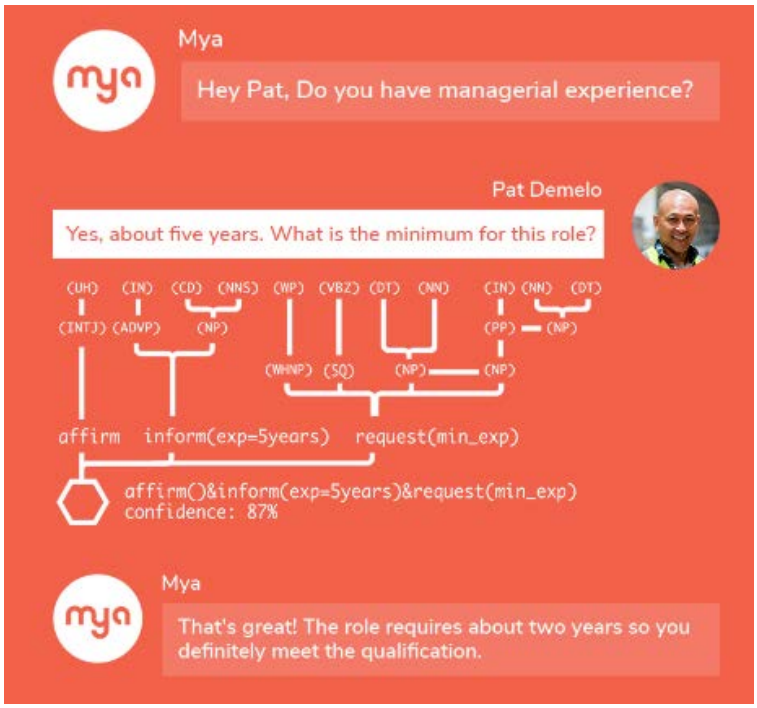
[17] https://www.entrepreneur.com/article/320763

One of the most time spending activity in the recruiting process, after the CVs screening, is the candidates' interview. Nowadays a job seeker is not only focused in the "open job positions" of his/her own country, but he/she can be even willing to seek a role abroad. The candidate sometimes cannot be able to go abroad in order to realize the interview; this could be a case in which an Artificial Intelligence software can be utilized.

Two developing startups specialized in AI interviewing software are: ***HireVue*** and ***Mya***. *HireVue* is a software company that provides video interviews for recruiting companies; it is currently working for more than 700 companies. The interview can be carried out On Demand: the candidate, using a computer, tablet or mobile device, could answer the questions prepared by the company for the position for which he is applying. The answers are recorded so that a representative of the interested company can evaluate them.

Mya is a leading conversational AI platform for hiring teams. The Mya platform retain crucial the "conversation quality", as it is showed in its website:

"Powered by our proprietary conversation engine, Mya leverages state-of-the-art natural language understanding and machine learning techniques to deliver the industry's most robust and engaging conversational experience. Through open-ended, natural and dynamic conversations, Mya is able to gather deep candidate insights and build trust and confidence with its users." [18].



Source: https://mya.com

[18] https://mya.com

A real case example of Artificial Intelligence application in the selection of the best candidate, during the hiring process, is the one of *Esselunga.*

Esselunga is an Italian company operating in the large-scale retail trade with supermarkets and superstores, focused mainly in northern and central Italy.

Thanks to the use of this innovative technology, Esselunga has been able to avoid almost 28.000 interviews, which can be translated into a very high number of hours and days saved in the selection process. This time saving gives the chance to the recruiting team to deal with other "adding-value activities".

As explained by Cristina Casadei in her article for Il Sole24Ore [19], the section process was developed in the following way.

To overcome *the first step*, the candidates who want to join Esselunga have to deal with a system made up of emails, text messages and video interviews in which Artificial Intelligence algorithms are tested. Esselunga started to work on this hiring process digitalization in 2018; after some months of algorithm development and tests, the project has taken the right direction.

The new method requires that the contact with the candidates takes place via SMS and email and then, after this initial contact, there is a 10-minutes interview.

In this way the company is able to carry out the first "screening phase": from the management of 50 thousand calls to the management of 20 thousand contacts.

The role of Artificial Intelligence algorithms is crucial in the video interviews, where it is applied to identify a ranking of candidates, based on an evaluation of specific soft skills recognized by the algorithm.

The best candidates in the ranking will then be invited to make a live video interview that will give access to the *last step*, namely the physical interview at the Esselunga site.

Esselunga wants to go ahead with the digitization of the selection process: a *chatbot* is in fact being studied to direct candidates towards the position that best responds to their skills and expectations.

In the past the Esselunga selective process was very traditional and involved a call to the phone, group interviews with about 60 people, micro-assessments in smaller groups with about 12 people and finally an individual interview.

[19] https://www.ilsole24ore.com/art/esselunga-intelligenza-artificiale-assumere-risparmiati-28mila-colloqui-AC3RJSQ

An analysis of this digital recruiting process shows that in the next 18 months almost 28 thousand physical interviews could be avoided, compared to those incurred in the same time period through the previous recruiting method.

It is important to underline how, in the final decision, the company does not give all the decision power to the Artificial Intelligence; in fact the final step of the hiring process is carried out by the HR managers, so the responsibility to choose the best candidate to hire is in their shoulders. This mean that, even if the company's trust on the AI algorithms is very high, it is aware that the *discretion* and the *critical capacity* of the humans, for the moment, cannot be overcame.

2.3.1 Artificial Intelligence in human resources management: Challenge and path forward

The scholars Peter Cappelli, Presanna Tambe and Valery Yakubovich, in their paper called *"Artificial Intelligence in human resources management: Challenge and path forward"*, developed a framework named "**The AI Life Cycle**" that represents the life cycle of an AI-supported HR practice, shown in the figure below.

The AI Life Cycle consists of 4 different phases:

1) Operations. In the HR practice, the Operations phase represents the way in which an organization hires employees. This phase, as showed previously, is characterized by a large amount of activities, which imply significant investment of money and weighty amount of work for the employees. The most common operation in HR, presented by Cappelli, Tambe and Yakubovich (2018) are:

HR operation	**Prediction task**
Recruiting – identifying possible candidates and persuading them to apply	Are we securing good candidates?
Selection – choosing which candidate should receive job offers	Are we offering jobs to those who will be the best employees?
On-boarding - bringing an employee into an organization	Which practices cause new hires to become useful faster?

Source: https://www.researchgate.net/publication/328798021_Artificial_Intelligence_in_Human_Resources_Management_Challenges_and_a_Path_Forward

Training	What interventions make sense for which individuals, and do they improve performance?
Performance management – identifying good and bad performance	Do our practices improve job performance?
Advancement – determining who gets promoted	Can we predict who will perform best in new roles?
Retention	Can we predict who is likely to leave and manage the level of retention?
Employee benefits	Can we identify which benefits matter most to employees to know what to give them and what to recommend when there are choices, and what are the effects of those benefits (e.g., do they improve recruiting and retention)?

Source: https://www.researchgate.net/publication/328798021_Artificial_Intelligence_in_Human_Resources_Management_Challenges_and_a_Path_Forward

2) Data Generation. All the operations shown above are composed by several tasks, and each task needs huge amount of data collection to be performed. All these data, of different formats (e.g. texts, records), need to be converted into a "digital format" and became a fundamental element to build ***recruiting algorithms***.
3) Machine Learning (ML). It involves set of techniques to create algorithms through data learning, in order to perform tasks better. In the business environment, the ML is often utilized as "supervision" applications; in statistical area is commonly used as prediction algorithm for the logistic regression. "For hiring, for example, we might see which applicant characteristics have been associated with better job performance and use that to select candidates in the future" (Cappelli et al, 2018)
4) Decision-making: the last stage of the AI Life Cycle. It represents the way in which the workers apply and implement the "output" of the Machine Learning phase in the day-by-day operations. Nowadays, the managers that work in the HR area have an higher level of discretion in the way in which they use empirical evidence from data science

than they did in the past, where the recruiting practices were standardized across the company.

Summing up, the main advantages of AI applications in Human Resources are:

- automate part of the workflow, in particular the amount of highly repetitive tasks;
- time savings and improvement in recruitment quality, thanks to increasingly standardized job matching;
- overcome the unconscious biases of recruiters, guaranteeing a fair selection process in order to meet the company objectives.

2.4 AI applications in Supply Chain Management

The Artificial Intelligence is spreading in every area of the companies, but perhaps its greatest impact could be on the supply chain and operations management; Artificial Intelligence has the power to significantly increase efficiency in the whole the supply chain.
The specialized site *LogisticaEfficiente.it* [20] presents some specific applications of Artificial Intelligence in the supply chain area that can bring benefits and improvements in terms of operational efficiency:

- *Equipment Maintenance*: the application of AI sensors to different equipment gives the chance to a company to collect the data related to the health status of the machines and to cross them with the history of maintenance operations, as well as with the data contained in the different "technical data-sheets" of the equipment itself. Thanks to this AI application, it is possible not only to automate the maintenance process, but also to identify the best moment in which to carry out interventions, in order to minimize production stops.

  The company therefore has the opportunity to pursue a dual objective:

  1. To increase the productivity thanks to the minimization of production stoppages;
  2. To cut maintenance costs thanks to a better management and scheduling of maintenance interventions, combined with constant monitoring of equipment performance

[20] https://www.logisticaefficiente.it/logisticaefficiente/management/guadagnare-efficienza-nella-supply-chain-con-l-intelligenza-artificiale.html

- *Robots utilization*: Artificial Intelligence technologies and algorithms can manage and control several robots starting from a single digital panel. Robots are generally used for repetitive tasks that could be dangerous if performed by a worker; this lead to greater safety within the working environment.

  Furthermore, the introduction of robots inside the warehouses entails considerable benefits in terms of productivity, because of higher level of speed and processes standardization.

- *Inventory management*: the use of Artificial Intelligence technologies allows to implement and use accurate demand forecasting models; in fact it is estimated that the forecast error can decrease by 20 to 50%, leading to a reduction in lost sales of 65%, at best [21]. The immediate benefit can be represented by an improvement in the performance linked to the inventory management. In fact, correct and timely forecasts allow the company to identify the adequate quantities of goods to be kept in stock, reducing "safety stocks" and limiting lost sales (in case of volatile demand) due to the absence of products in stock.

  It is important to point up that the presence of high "safety stock" entails huge stock-holding cost that a company has to face. As a consequence, the reduction of "safety stock", thanks to AI technologies, represents a relevant cost saving for the company.

- *Inventory control and planning*: "[…] an expert system may be incorporated into the material requirement planning system so that it can store data bases regarding historic master production schedules, bills of materials, and order patterns and then develop systematic lot-sizing rules to estimate the optimal level of future orders and the optimal timing of inventory replenishments. Another intriguing application of AI techniques to inventory control and planning includes the recent study of Teodorovic et al. (2002) who developed fuzzy logic rules to make online, intelligent, airline seat inventory control decisions as to whether to accept or reject any passenger request for seating arrangements." *(Hokey Min, 2008)*

- *Supplier management*: Artificial Intelligence technologies allow not only to obtain more precise information about consumer demand, feeding predictive models, but above all

[21] https://www.logisticaefficiente.it/logisticaefficiente/management/guadagnare-efficienza-nella-supply-chain-con-l-intelligenza-artificiale.html

enable greater synchronization between the company and suppliers; in fact, in order to improve the company efficiency, the communication with suppliers is crucial.

As showed previously, AI technologies enables an accurate demand forecasts and, thanks to this, suppliers can thus avoid overproduction. In particular, the suppliers can also improve their production and delivery plans, monitoring the customer's stock data; the client company has in fact the possibility of sharing on cloud platforms data collected by AI technologies, enabling the supplier to access extremely important information, such as inventories level.

- *Management of shipments*. Even the management of shipments can benefit from the role of AI technologies in increasing the accuracy of forecasting models; AI, in fact, is able to process and take into consideration crucial aspects such as weather conditions and traffic conditions. These AI algorithms are able to predict and optimize the times associated with the shipment, allowing the company to plan and adequately prepare its resources for this activity.

  Some innovative and automated shipping methods, such as the “self-driving truck” that works thanks to AI technologies, are in phase of experimentation.

In Operations management, the role of AI technologies could be crucial in order to reduce the so called “avoidable losses”, that are the losses not planned by the company.

Taking a step back, it is important to underline the difference between the *planned losses* and the *avoidable losses:* the planned losses represent the waste of time (or waste of capacity) that are already planned and scheduled by the company (e.g. set-up time, changeovers, preventive maintenance); on the contrary, the avoidable losses represent the waste of time (or waste of capacity) that cannot be planned neither anticipated by the company (e.g. breakdown of machineries, reactive maintenance, labor shortages).

These losses are key measures in order to reckon the *effective capacity* and the *actual output* of the plant.

- Effective capacity= Design Capacity – Planned losses
- Actual Output= Effective Capacity- Avoidable losses

The Design Capacity in defined as the overall capacity of the plant in case of absence of losses, but taking into consideration the presence of an eventual bottleneck.

The Effective capacity represents the overall capacity of the plant net of planned losses.

The Actual output represent what the company is actually able to produce, after have taken into consideration the planned and avoidable losses (Slack et al, 2016).
The implementation of AI technologies could help the company in reducing the avoidable losses, mainly thanks to their ability to collect the data related to the health status of the machines and to cross them with the history of maintenance operations. This gives the chance to the company to measure and forecast with high level of accuracy the potential unplanned losses; as a consequence, the corporation is able to improve the so called "utilization rate", that is the result of the ratio between actual output and design capacity.

ThePrucurement.it[22] shows some examples, presented by Forbes, of the innovative AI application in supply chain management:

- *Rolls Royce* has recently partnered with *Google* to create autonomous self-driving ships, with the aim to cross oceans more quickly and more easily. These ships use AI technologies to detect objects around them in the water and to classify them based on the degree of danger to which the boat is exposed; in this way, ships do not run the risk of hitting dangerous objects. Further implementations involve the inclusion of sensors to track ship engine performance and to monitor safety conditions.

- *Ups*, an American company for international shipping, uses Orion (On-road Integrated Optimization and Navigation), a GPS system based on Artificial Intelligence, to create more efficient routes for its fleet; in this way, drivers can deliver on time and can improve their efficiency. Furthermore, depending on the road conditions, the drivers can change the route during the race.
  The AI technology works in this way: customers, drivers and vehicles enter data into the device, which then uses the algorithms to create optimal routes. The benefits of these systems are mainly related to the cost savings, reduction of truck wear and of polluting emissions.

- *Marble*, a global supplier of transport and logistics solutions, delivers all kinds of goods with robots. The advantage of using robots based on AI technologies rather than human carriers is mainly related to goods for which delivery times are essential, such as perishable food and medicines.

[22] https://www.theprocurement.it/supply-chain/cinque-esempi-utilizzo-dellintelligenza-artificiale-nella-supply-chain/

The technology used by Marble is called Lidar and allows robots to travel on sidewalks without colliding with people or other obstacles; this thanks to the robots trace their own itinerary and the conditions of the sidewalks along the road, so the routes are continuously improved.

- *Lineage Logistics*, a company that keeps food cold on behalf of food shops and restaurants, uses Artificial Intelligence algorithm to forecast the course of its orders; in particular, the algorithm can predict when the orders will arrive in the warehouse and when they will leave it, so the employees can place the pallets in the best position.

- *Infinera,* a listed telecommunications company, uses a AI machine learning system to analyze production times and to more accurately predict the delivery date. In particular, the AI algorithm combines past delivery information with customer feedback, weather forecasts and logistics; then, it provides information to sales managers and customers, in order to inform them about the availability of products and accordingly, when they can be delivered.

  In this way the company is able to make faster and more consistent decisions and increase customers satisfaction.

2.5 AI and Industry 4.0 tax relief.

As seen in the previous paragraphs, the applications of Artificial Intelligence in companies are manifold.

In recent years, the Italian government has set tax incentives and tax relief for companies that have focused their business on innovation through the technologies inherent in the world of Industry 4.0.

The “Piano Nazionale Industria 4.0” (National Industry 4.0 Plan) is an incentive package for companies that invest in digital innovation and technological transformation. It provides, for the digitalization of industrial and manufacturing processes, relevant tax relief.

The Italian government approved in 2018 an economic maneuver which includes several reforms for the Industry 4.0 plan.

The over-amortization regime is being reshaped including cloud services and establishing new funds for Artificial Intelligence, block-chain and Internet of things technologies.

To be able to enjoy the incentive, certain conditions must be met [23]:

- the investment must be made by 31 December 2019 or by 31 December 2020;
- the service provider must accept the order by 31 December 2019;
- A deposit of at least 20% of the total cost must have been paid;
- the beneficiary company must be located in Italy.

In addition, with a good Research and Development project, a company could be able to recover part of its investment [24], in particular:

- With an investment of 10 to 20 million euros the company can recover up to 50%;
- With an investment of 2.5 to 10 million euros the company can recover up to 100%;
- With an investment of up to 2.5 million euros the company can recover up to 170%.
-

The Italian politicians Pastorelli, Locatelli and Marzano made a legislative proposal, became law on January 1st 2018, related to the tax breaks for the use of Artificial Intelligence systems in the production of goods.

Their legislative proposal is imposed in the light of the profound evolution that the industrial world will experience in the near future: the use of Artificial Intelligence systems, combined with constant advances in robotics, create a concrete risk of obsolescence of the human workforce.

In fact, in less than twenty years, many professionals, especially in the industrial and manufacturing sectors, could be replaced by intelligent robots which will carry out the same tasks at significantly lower costs, generating a negative impact on employment.

It is therefore necessary to ensure that the growing use of Artificial Intelligence systems goes side by side with the widespread reconversion of the human workforce, creating new professional; in addition the companies should continue to update the capacity of the worker, in order to let them to be indispensable to the productive structure [25].

The Pastorelli, Locatelli and Marzano law intervenes on the corporate income tax (IRES) increasing the tax rate by one percentage point, if the production activity is carried out and managed directly from intelligent machines.

[23] https://www.archimedia.it/blog/industria-4.0-agevolazioni-fiscali-il-momento-giusto-per-fare-inbound-marketing

[24] https://www.archimedia.it/blog/industria-4.0-agevolazioni-fiscali-il-momento-giusto-per-fare-inbound-marketing

[25]https://www.camera.it/leg17/995?sezione=documenti&tipoDoc=lavori_testo_pdl&idLegislatura=17&codice=17PDL0054410

This increase in taxation does not occur, however, if the company invests 0.5 per cent of its revenues in projects for the professional re-qualification of its workers or in corporate welfare tools.

The main aims of this law are [26]:

- to discourage the brutal replacement of the human labor force by the robotic one;
- to encourage companies to reconvert their human workforce and to equip workers with knowledge and skills that guarantee them a place in the labor market.

[26]https://www.camera.it/leg17/995?sezione=documenti&tipoDoc=lavori_testo_pdl&idLegislatura=17&codice=17PDL0054410

CHAPTER 3:

Artificial Intelligence: Best in Class Applications.

3.1 Partnership on AI to benefit people and society and Open AI.

Almost all the major Internet multinational companies such as Amazon, Facebook, Google, Microsoft, IBM and Apple have launched in 2016 (with the exception of Apple, which joined the group in 2017) a partnership to promote and deepen the Artificial Intelligence world; this partnership is called "*partnership on AI to benefit people and society*".

The members of this partnership have direct commercial interests in this field, and their main aim is to convince governments and citizens that Artificial Intelligence is not a danger, but an opportunity.

In fact, the resistance to the introduction of products related to Artificial Intelligence, such as self-driving cars, robots, smartphone assistants and predictive software, has been dictated not so much by technical reasons, but cultural and legislative ones [27].

In the intentions of the founders, the Partnership on AI will constitute a continuous working group on one of the hi-tech drivers (the AI), concerning five elements in particular: correctness in research, security, transparency, ethics and privacy.

In 2015 Elon Musk, Tesla's owner, launched an open source platform for the correct and responsible development of the Artificial Intelligence technologies.

The platform name is *Open AI* and its main aim is the improvement of knowledge and the creation of new algorithms which are the basis of Artificial Intelligence. The investment needed to create *Open AI* was of over 900 million euros and comes from the premise of making Artificial Intelligence "an extension of the human will" [28].

This AI project has also a "social" goal: through a no profit research platform it wants to facilitate people's daily lives and not damaging it.

The strong interest showed by all the major multinationals and world powers confirms the great ferment created in recent years around the AI world.

3.1.1 IBM: Watson

"IBM Watson is a cognitive computing platform originally developed by IBM […] on the company's DeepQA project, and its advanced question answering (QA) capabilities are now being utilized by IBM and enterprise customers in a variety of applications.

[27] https://www.lastampa.it/2016/10/07/tecnologia/non-abbiate-paura-dellintelligenza-artificiale-le-multinazionali-di-internet-si-alleano-per-fare-lobbying-hPmxgAogBLW3flSXOouWSI/pagina.html
[28] https://www.investireoggi.it/tech/open-ai-ecco-lintelligenza-artificiale-di-elon-musk/

[…] the Watson platform was developed to take in questions that are expressed in natural language and then utilize algorithms, Artificial Intelligence and a wealth of data (Big Data) to fully understand the questions and return as precise an answer as possible to the question." [29].
In order to replicate the human ability to answer questions, Watson platform needs 90 servers and 200 pages of information. It occupies 15 terabytes of RAM (*Random Access Memory*) and it is able to process almost 500 GB of information every second [30].
Prior the creation Watson in 2005, IBM's profits derived mainly from the sale of hardware, while today are relegated only to a 20% of margin. The heavy investment made by IBM in the AI project seems to have brought important result in terms economic growth [31].

3.1.1.1 How does Watson work?

Watson system is not only able to understand data and problems posed, but also to manage and process them to provide forecasts and solutions to which man could hardly come alone.
The specialized web-sites *Digitalic.it*[32] and *Webnews.it*[33] describes the Watson problem solving capabilities; in fact it is able to work by following steps similar to those adopted by human reasoning.
A "human" decision-maker usually follow this four different phases:

- Observation of the facts and analyzation of the question asked;
- Interpretation in order to generate hypotheses;
- Assessment of hypotheses with relative distinction between the right ones and the wrong ones;
- Choice of the best hypothesis, which leads to the solution.

Watson's brain works in a very similar way and, unlike a normal computer, it is able to process and understand unstructured data, that represent the largest kind of the data gathered by a company every day.
In particular, according to the web-site *Webnews.it*, the Watson system works following these four steps:

- Analysis of the query, so that it is well defined and interpretable.
- The text of the query is linked to the existing AI knowledge, disambiguating its meaning starting from the context identified.

[29] https://www.webopedia.com/TERM/W/watson.html
[30] https://searchenterpriseai.techtarget.com/definition/IBM-Watson-supercomputer
[31] https://www.digitalic.it/tecnologia/innovazioni-tecnologiche/watson-intelligenza-artificiale
[32] https://www.digitalic.it/tecnologia/innovazioni-tecnologiche/watson-intelligenza-artificiale
[33] https://www.webnews.it/speciale/watson/

- Reports are extracted from the text of the query in order to deepen understand it.
- The AI is able to learn as a consequence of the acquisition of information from the text. This increase the AI knowledge, on which the subsequent queries will be analyzed and solved.

The previous steps shows that it is possible to feed Watson not only with structured data, that are information already organized that can be easily transformed into knowledge, but also data that have not been yet associated with each other.
Watson AI has been initially trained based on machine learning and deep learning, thanks to the gather of several information.
The Watson AI database has been constituted thanks to data collected from a lot of different sources, such as: encyclopedias, articles, research results, but also from posts from the social networks.
It is important to underline that, when the Watson project was launched in 2005, human intervention has played a key role. The IBM experts have checked that all the inputs entered in the Watson system were exact and updated; in fact, for a perfect AI brain, it is fundamental to pay attention to the content submitted to the system.
The IBM experts work have allowed the Watson's brain to acquire patterns that allow it to identify relationships and associations independently. It is possible to affirm that the Watson Artificial Intelligence has been developed through a "learning by doing approach"; in fact the system is able to extend his cognitive experience by learning from its successes and from its failures, attempting to repeat the actions carried out in cases of success and not to repeat the actions carried out in the event of failure.

3.1.1.2 Watson services to companies.

There are several Watson applications in companies; *ZeroUnoWeb.it*[34] shown the main ones:

- Watson in **agricultural sector**:
  IBM has created a platform called "Watson Decision Platform for Agriculture" and made it globally available. The main benefits that this platform can deliver are:

[34] https://www.zerounoweb.it/analytics/cognitive-computing/9-applicazioni-di-intelligenza-artificiale-ecco-i-nuovi-servizi-ibm-watson/

- "*Improved crop protection* by leveraging AI to better understand and proactively alert growers to critical daily crop stress levels, identify signs of pests and diseases, and more effectively assess current risk levels of crops.
- *Increased yield optimization* with benchmarking and validation against yield models for comparable soil and weather conditions as well as support for better decisions around irrigation, product application, and planting and harvest timing.
- *Smarter in-season trading* with productivity assessments and decision guidance as well as probabilistic weather conditions that feature detailed analysis of sub-seasonal and seasonal forecasts." [35].

To offer these benefits, the Watson agricultural platform must collects data from multiple sources, such as: weather, machinery, irrigators and satellite images. In order to gather all these data it is necessary that the farming company works through IoT technologies.

Thanks to this platform the individual farmer obtains the support to make better decisions, with the final aim to improve the yield of the land. For example, using the AI visual recognition features, the farmer can identify the type and levels of damage caused by pests and find the best way to solve the problem.

- Watson in **customer service:**

  IBM has created the "Watson Discovery for Salesforce", an AI technology that increase the ability of customer service employees to solve complex requests and to increase the speed of response to the customers. In fact, this Watson platform offers, in real time, all relevant information on the queries made by the customers.

  Contrary to what happens with common Artificial Intelligences, the long training periods are no longer necessary: Watson immediately presents the most likely solution, making even junior agents as effective as experienced professionals.

  "Watson Discovery for Salesforce lets you easily ingest your company's data from a variety of common enterprise data sources. […] Once all the knowledge

[35] https://www.ibm.com/downloads/cas/PRJL6ZW4

of your business has been ingested, Watson Discovery for Salesforce can draw upon that information, plus past customer cases and issues, to provide agents the understanding they need to serve your customers and keep them happy. Watson uses AI to analyze unstructured data within and outside of Salesforce […].

It learns from past customer cases to improve with every interaction, and understands what's relevant to your business, your customers, and your service reps, to proactively recommend pertinent solutions." [36].

- Watson in **Human Resources**:

  IBM's AI functionality provides a better indicator of the probability of successful employment and it can help in removing a significant percentage of errors during a decision-making process. It helps the recruiters in the analysis of the best performing background in different contexts, using that gathered data to signal the most promising candidates.

- Watson in **Marketing and Advertising**:

  IBM has launched "WEATHERfx Footfall", a project that uses the Watson AI in order to design advertisements based on changing weather patterns. This means that the virtual billboards automatically change on the base of the wheatear and the outdoor temperature. "WEATHERfx Footfall" project has been applied by Subway – the American fast food restaurant – leading to amazing results: during its advertising campaign, Subway increased the in-store traffic by 31% and reduced the waste by 53%, which made possible to save about 7.9 million [37].

- Watson in the **Industrial Production:**

  IBM is releasing special Watson tool that, combining IoT and AI, will stabilize the production costs. This tool works through the identification and prediction of areas of loss such as: waste of electricity, equipment breakdowns and product quality problems. The IBM Watson tool will significantly reduce resource needs through a visual and acoustic product inspection.

[36] https://www.ibm.com/blogs/watson/2018/09/introducing-watson-discovery-for-salesforce-an-ai-powered-insight-engine-for-crm/

[37] https://www.corrierecomunicazioni.it/digital-economy/ibm-fa-crescere-watson-ai-a-servizio-di-marketing-e-automotive/

- Watson in the **construction industry:**

  The IBM IoT Buildings Insights combines the industrial IoT with the Artificial Intelligence. This technology decodes the data produced by the analysis of buildings, mainly related to the weather forecast and current performance, in order to understand the consumption dynamics and reduce the energy costs. In addition this AI tool could help the builders in defining the right schedule for the predictive maintenance.

- Watson in the **distribution:**

  Thanks to the AI tool *Watson Supply Chain Insights*, Watson is able to incorporate weather data, traffic reports and even regulatory reports to reduce interruptions, to optimize performance and to improve supply chain decision making.

3.1.1.3 What about the Turing Test?

According to IBM the Turing Test problem, at this stage, does not arise. In fact it is useless to think of a machine that relates to the person without friction and without all the semantic richness that a direct relationship requires.
It is too early to consider the Artificial Intelligence as smart as man; this means that wandering if Watson would be able to pass the Turing Test it is wrong.
IBM's goal is not to replace individuals; indeed, it intends to present itself as the best complement to individuals, enhancing their abilities thanks to a symbiotic role in perfect complementarity with the human nature.
The input and output remain in the hands of the user, who also has the duty to validate the quality of the process carried out by the machine.
Watson's Artificial Intelligence does not intend to overcome the individuals, but to exalt their intelligence [38].

3.2.1 Amazon and AI

Alessandro Giaume (2018) defines Artificial Intelligence as the most important ally of managers and companies to obtain important competitive advantages in the reference markets.

[38] https://www.webnews.it/speciale/watson/

Artificial Intelligence also plays a key role as a prediction technology, so large companies like Amazon exploit all the channels they have at their disposal to collect data for forecasting purposes.
Amazon is able to collect data within its e-commerce site (by looking at online consumer purchases), in social networks, but also through *Alexa*.
Alexa is an intelligent assistant: it is the tool that Amazon has designed to offer users the possibility of interacting through voice commands with algorithms capable of opening up a long series of opportunities. The Amazon idea is that of a constantly evolving this service, which can be continuously enriched and which, through interaction with the user, is able to learn new skills, new types of answers and new dialectical nuances able to increase the empathy between the machine and the individual.
Alexa is based on a set of AI algorithms and functions behind the devices within which Amazon gave “body” to its assistant [39].

Amazon's business model has changed considerably in recent years: today Amazon needs a reliable supply chain to avoid delivery delays.
Consequently, for a company like Amazon, the forecasting activity plays a fundamental role: by managing to have an excellent forecasting capacity, Amazon would be able to considerably reduce the goods in stock, consequently reducing the capital immobilization.
In the future, Amazon may be able to anticipate the customer's order, moving from a "shopping then shipping" model to the exact opposite, "shipping then shopping" (Giaume 2018); the customer could receive the product at home (which Amazon expects may be of interest to him/her) and then evaluate whether to buy it or not.
A key choice in following a strategy based on Artificial Intelligence lies in correctly defining the *timing of the investment*:

- An upfront investment, and particularly without enough data to "feed" the Artificial Intelligence, would lead to a wasted investment for the company.
- Investing late would not allow competitive business strategies to be followed.

Amazon bases most of its activity on systems based on machine learning. Without machine learning, Amazon would not have achieved exceptional results in terms of growth, customer experience and quality and speed of logistics.

[39] https://www.punto-informatico.it/speciali/amazon-alexa/

Amazon has created *AWS* to allow other companies to take advantage of the same IT infrastructure that it uses, giving the chance to other companies to benefit of its agility and low cost. In addition, Amazon would like to make machine learning technologies available to all companies.
The structure of Amazon's development teams and the importance given to ML technologies for solving practical business problems allows Amazon and AWS to develop powerful and intuitive machine learning tools and services. Like many other IT services, these tools are firstly tested by Amazon and only then they become available to all companies.

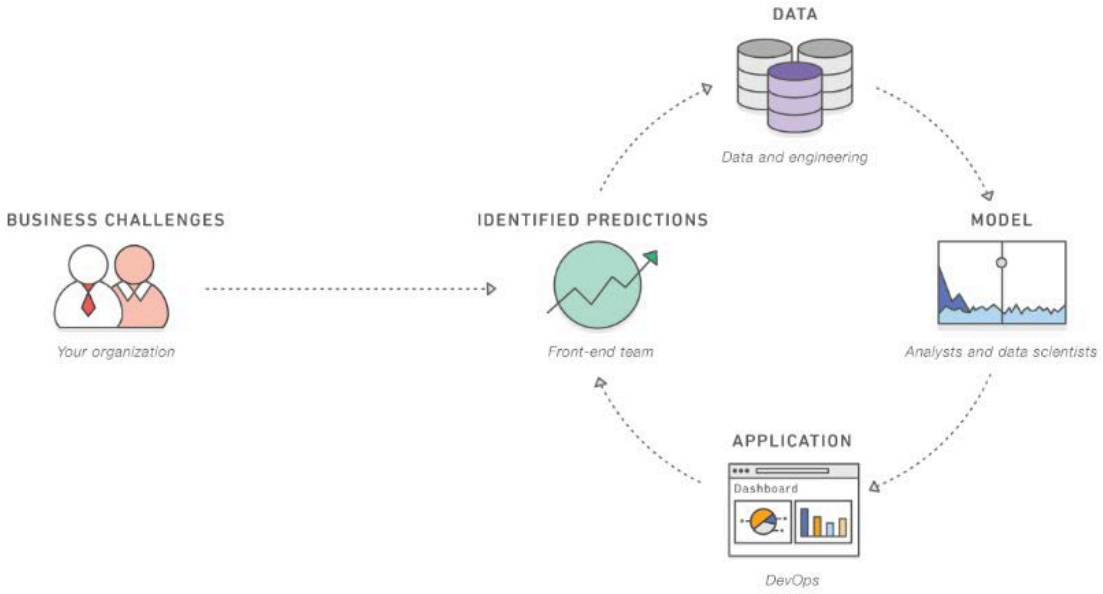
External companies often use machine learning software to provide predictions based on historical data. For example, many companies use it to predict the amount of products that will be sold in subsequent fiscal quarters based on specific demographics, or to estimate the profile of the typical customer that will most likely show greater or lesser brand loyalty [40].
These forecasts allow the companies to make informed decisions, create more personal user experiences and reduce customer retention costs. Machine learning and Business Intelligence are strictly related and complementary; while the Business Intelligence collects data from the past, the Machine Learning provides forecasts about the future based on past trends.
However, the implementation of machine learning in the company involves several phases, that are showed in the site *Amazon.com*:

- First of all, it is necessary to identify the area in which the forecasts would allow greater advantages;

- Once done it, it is important to collect data based on specific business parameters such as transactions or sales;

- When the company has enough aggregated data, it is thus possible to create an automatic learning model. The model will provide forecasts that can be reused in company systems to make informed decisions.

[40] https://aws.amazon.com/it/machine-learning/what-is-ai/



Source: https://aws.amazon.com/it/machine-learning/what-is-ai/

Amazon.com[41] also shows the main cases of use of Machine Learning and Artificial Intelligence within a company:

- Detection of anomalies (identifies elements, events and observations that do not conform to a predetermined pattern);

- Detection of fraudulent activity (create predictive models that facilitate the identification of potentially fraudulent transactions);

- Customer abandonment rate (find customers at risk of being abandoned, so you can engage them in advance with promotions and customer service offers);

- Content customization (predictive analysis models that allow you to recommend articles and optimize the flow of the website based on previous customer actions).

[41] https://aws.amazon.com/it/machine-learning/what-is-ai/

3.3.1 Google AI

Google is working to expand the audience that can access to solutions based on Artificial Intelligence, mainly related to the voice interaction.
The companies that are interested in this kind of service acknowledge that the ability to recognize and synthesize the voice is fundamental to make human-machine interaction more natural and simpler.

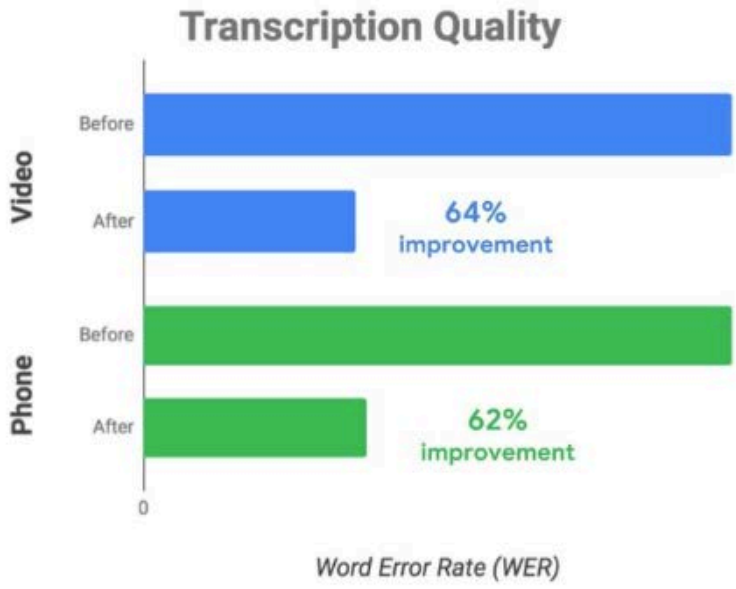
Google has recently taken a new step to make Cloud Speech-to-Text and Text-to-Speech products accessible to more companies around the world [42].
Google Cloud Speech-to-Text allows the clients to convert audio to text by applying effective neural network models, through one of the most advanced deep learning neural network algorithms.
The accuracy of Cloud Speech-to-Text improves over time as Google optimizes the internal voice recognition technology used by Google products [43].
This service could become fundamental within a company, thanks to the possibility of writing down everything that is said within a meeting and that could be subsequently consulted to complete the various set tasks.

A Google AI software useful for analytics on calls or meetings, and for other use cases involving multiple participants is the *multi-channel recognition*. This helps the Speech-to-Text Cloud APIs to distinguish between multiple audio channels: for example, different people in a conversation [44].
However, in order to bring this technology into the company and to make it crucial, for example, in the board of directors meetings, the percentage of error must be minimal.
For this reason Google is working to improve the quality of these technology, and, in the last year, it has been able to realize 62% fewer transcription errors in the phone model, while the video model has 64% less errors.

The most important aspect of this technology, which makes it useful for companies, is related to the fact that the video model also works in environments with multiple speakers, such as meetings or podcasts.

[42] https://www.01net.it/google-apre-intelligenza-artificiale-vocale/
[43] https://cloud.google.com/speech-to-text/?hl=it
[44] https://www.01net.it/google-apre-intelligenza-artificiale-vocale/

It is able to distinguish among different speakers and to ignore the background noise.



Source: https://www.01net.it/google-apre-intelligenza-artificiale-vocale/

3.3.1.1 Google AI principles

The application of software related to Artificial Intelligence always opens up questions about the "ethical correctness" in their usage.
An international business reality like Google cannot afford to fall into accusations linked to the non-ethical nature of its technologies, which according to many tend to replace the role of the individual within the company.
For this main reason Google – in its website *ai.google* [45] - has defined seven Artificial Intelligence principles that represents its objectives for a correct and fair AI application.

- *Be socially beneficial*: Google would like to utilize the AI in order to have a positive impact on health care, security, energy, transportation, manufacturing and entertainment; in addition, it wants to respect the cultural, social and legal standards in the countries in which it operates.
- *Avoid creating or reinforcing unfair bias.*

[45] https://ai.google/principles/

- *Be built and tested for safety*: Google AI system is appropriately cautious, and it is develop it in accordance with best practices in AI safety research.
- *Be accountable to people*.
- *Incorporate privacy design principles.*
- *Uphold high standards of scientific excellence: "*AI tools have the potential to unlock new realms of scientific research and knowledge in critical domains like biology, chemistry, medicine, and environmental sciences" [46].
- *Be made available for uses that accord with these principles.*

3.4.1 How to bring AI into Italian companies?

After analyzing how the international technology giants - like IBM, Amazon and Google - are giving Artificial Intelligence a key role in their business, it is important to understand how Italian managers should act to risk not being late in applying this technology.
Obliviously, in order to be a pure AI user, it is necessary to have enough AI skills.
In fact, knowing how the AI software work - so the way in which it produces results - helps the managers not to be overwhelmed by its errors, its bias, intentional or unintentional.
Sometimes it could be useful to test the AI software with alternative paths, never tried before, with the sole purpose of challenging the already known solutions; this could help the managers to avoid relying on the algorithm with "eyes closed", as well as being aware that it can be misled by uncontrollable factors.
Computers give only apparently refined solutions, for this reason there is the need to instruct the machine and interpret the results with a continuous control.
The research field aimed at tracing, measuring and interpreting the AI results is called *explainability*.

"Explainability is the first step in achieving a transparency goal which can be achieved by checking systems explanations to determine whether they desirable trust criteria.
Because machine learning models are opaque, non-intuitive, and thus difficult for people to understand, an explainable AI will be essential if users are to understand, appropriately trust, and effectively manage this incoming generation of artificially intelligent partners." *(Arai, Bhatia and Kapoor, 2019, p.1276)*

[46] https://ai.google/principles/

Fairness, on the other hand, is the area of study that aims to protect against the errors of the AI algorithms, especially when they impact on sensitive issues such as ethnicity, equal opportunities, ethics and values.
In fact, algorithms based on historical series tend to associate certain professions with one gender rather than another, or certain crimes with that or that other ethnicity, favoring prejudice and crystallization [47].

In a company, every radical change - such as an Artificial Intelligence project - normally starts from the identification of a need for saving or from the opportunity for additional revenues.
Since the AI is applicable to almost any field, it could be helpful for the Italian managers to speak with AI experts, in order to better identify the areas of interest where the AI could generate the best results.
The ideas on the AI applications can come also directly from the market: for example, from competitors' use cases, supply chain meetings, contacts at fairs and open innovation [48].

Obviously, as showed in the previous chapters, the roots of any AI project are in the amount of data that the company has at its disposal or that it is able to generate; this represent the main link between the Artificial Intelligence and Internet of Things.
In the last years, also thanks to the development of the IOT, the quantity of available data has grown, and, with the continuous improvement of the AI, the ways to use them become more and more articulated.
In order, for Italian managers, to be able to exploit the full potential of Artificial Intelligence - whether it is embedded in systems, or it is designed ad hoc - it is essential for them to know the AI operating logics in the field.
For this reason, today's managers need a different training model, which must be innovative and able to give a level of awareness equal to that of experience in the field.
In order for the manager to be able to acquire security and familiarity, they have to move from an attitude of protection of his role to that of promoter of change.

The Italian managers have to understand:

- what the AI is and how to apply it;

[47] https://www.digital4.biz/executive/innovation-management/intelligenza-artificiale-in-azienda-una-guida-per-i-manager/
[48] https://www.digital4.biz/executive/innovation-management/intelligenza-artificiale-in-azienda-una-guida-per-i-manager/

- how to validate the suppliers and how to take it to the company;
- how to choose consultants and how to empower them.

However, to implement an AI technology it is not enough only trying to revisit a business process, but it is fundamental to train the employees on the base of the so called *"Fusion Skills"*.

The *Fusion Skills* represents those skills that enables the workers to work effectively at the human-machine interface: they "draw" the fusion of human and technological talent within a business in order to create better results than when they work independently.

The first step is to learn how to delegate the tasks to the AI technologies and not to be scared in doing it.

Workers have to trust the machines in order to be able to better combine their distinctive capabilities with the innovative skills of the AI technologies; in this way the employees could be able to achieve a better outcome than either could achieve alone.

Workers must be able to teach new skills and tasks to the AI technologies and to train them in order to enhance the AI process.

In addition, employees should know which the best way is to formulate the questions to the Artificial Intelligence software in order to receive the answer they need *(Davenport et al, 2019).*

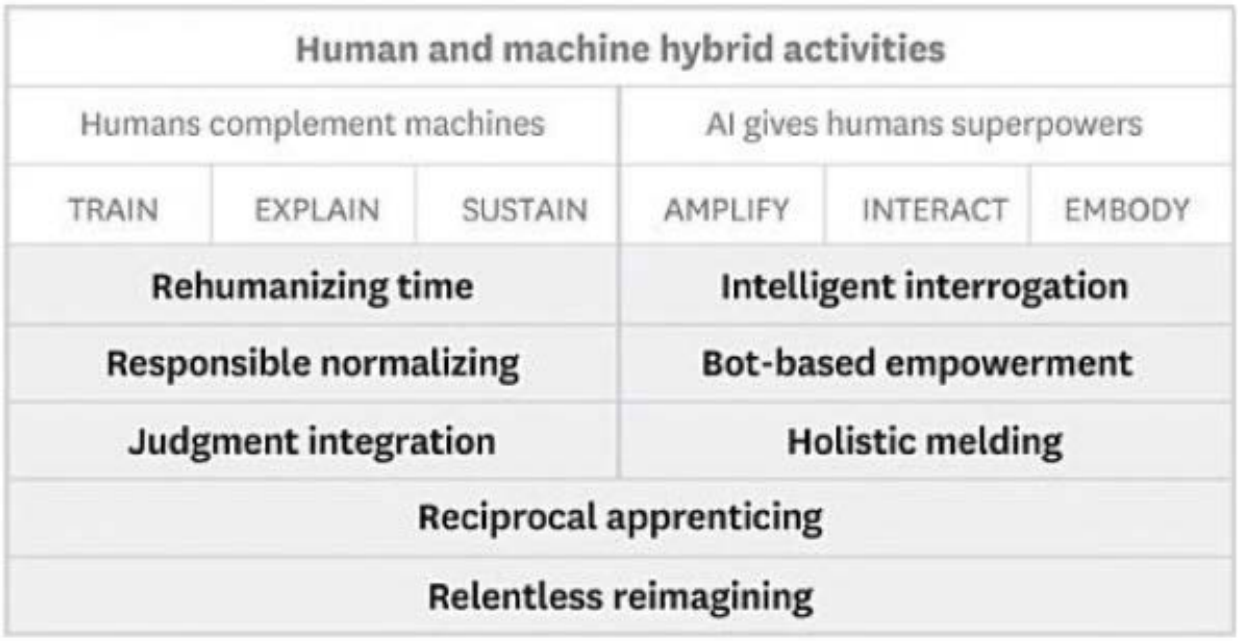
Daugherty and Wilson (2018) describes eight Fusion Skills that should guide managers and workers in developing a workforce capable of extract the maximum value from the combination of human and machines.

In particular:

- three of the fusion skills allow people to help machines (on the left side of the following table);

- three of the fusion skills give the workers the chance to be augmented by the machines (on the right side of the following table);

- two of the fusion skills help workers to work in the both side of the following table.



Source: Daugherty and Wilson (2018)

Accenture, management and strategic consulting multinational company, – in its website *Accenture.com* [49]- describes every fusion skill in the following way:

- *Rehumanizing time*: It represents a new way of thinking about working time. Individuals will have more time to devote to the "human tasks", such as increasing interpersonal interactions and conducting creative research.

- *Responsible normalizing*: It is necessary to rethink and "normalize" the human-machine interaction in relation to individuals and businesses.

- *Judgment integration:* In some cases, a machine may be uncertain about what to do in a specific situation. People must be prepared to understand where, how and when to intervene to provide input.

- *Intelligent interrogation*. In order to obtain the insights that the workers need, it is essential to ask machines the right intelligent questions on several levels of abstraction.

[49] https://www.accenture.com/us-en/blogs/blogs-work-reimagined-8-skills-age-ai

- *Bot based empowerment*: Various robots are available to help people to be more productive and improve their work. The AI software can give the chance to the managers to reinvent the business processes.

- *Holistic melding*: "In the age of human-machine fusion, holistic melding will become increasingly important. The full reimagination of business processes only becomes possible when humans create working mental models of how machines work and learn, and when machines capture user-behavior data to update their interactions." [50].

- *Reciprocal apprenticing:* Through the AI technologies, machines have to learn from humans and humans, in turn, have to learn from machines. In the future, workers will perform activities together with AI technologies in order to learn new skills.

- *Relentless reimagining*: This hybrid ability is the ability to re-imagine how AI can transform and improve work, organizational processes, business models and even entire sectors.

[50] https://www.accenture.com/us-en/blogs/blogs-work-reimagined-8-skills-age-ai

CHAPTER 4:

Artificial Intelligence in Italian Manufacturing: Qualitative Research.

After a general analysis of the Artificial Intelligence applications, it is necessary to go deeper into the world of Italian manufacturing, in order to evaluate all the growth potentials and criticalities that follow the application of such advanced technology.

In the last years the race for *innovation* has become stronger and stronger. Many companies have seen the technologies of Industry 4.0 as the way out of the 2008 crisis. Italian manufacturing undoubtedly benefited from this innovative process, which has allowed small businesses to expand worldwide. In recent years, some pioneering innovation companies have decided to enter in the Artificial Intelligence world, full of great potentials, but also of criticalities.

As a matter of fact, on the base of the general review of Artificial Intelligence done in the previous chapters, it seems that this technology could be crucial for the future growth of the innovative and forward-looking companies.

It is universally recognized – as showed by Sesto Viticoli (2017) in his book “Verso un manifatturiero italiano 4.0” - that the manufacturing sector plays a crucial role in the development of both advanced and developing economies, and how its futures is conceivable only following an "Industry 4.0" model.

Today's debate is dominated by the opportunity and the importance of introducing various digital technologies (such as Big Data, IoT and Artificial Intelligence) within corporate processes and organizations, also as a source of solutions to business issues; however it is fundamental to keep in mind that the introduction of these technologies into a company can also lead to new problems to cope with.

For this reason, the best approach in the application of advanced technologies - such as Artificial Intelligence - is not to consider it as a revolution to be implemented in a very short time, but rather a cultural evolution to be carried out in a suitable time frame.

It seems certain that the Artificial Intelligence will be one of the factors behind the internal change of companies. This technology will make the machines and robots capable of interacting with each other and able to learn from the several scenarios of the production processes of SMEs; this change could guarantee more efficiency and lower costs for businesses.

But, in order to manage the “factory of the future” and to face the challenges of the fourth industrial revolution, qualified human resources are needed [51].

In fact the role of the individual - as it will be possible to observe later in the qualitative analysis carried out - plays a key role even in dealing with such advanced technologies; but it is crucial to note that intelligent machines have a dramatic advantage over people: while a human worker slowly learn from the successes and failures that he faces, on the contrary machines learn instantaneously from successes and failures of a multitude of other connected machines, even if far away in geographical terms.

As explained in the scientific site “*IndustriaItaliana.it*”, thanks to the learning capability of machines it will be possible to ascertain that the productivity of a machine will evolve over time and, furthermore, two identical machines could become to some extent different from each other due to alternative *learning paths*.

Since each machine can "interact" through the network with other machines (regardless of their physical proximity), it is therefore possible to develop *economies of scale* and *synergies* that depend on the level of interconnection of each machine but disregard the physical proximity of these machines.

So, it is possible to affirm that the Artificial Intelligence technologies will allow the realization of economies of scale, efficiency and cognitive enrichment; these benefits could also be reached with reference to a plurality of small plants connected to each other albeit physically distant.

However, it is difficult to predict how the digital transformation will become radical in the manufacturing area.

Surely, the campaign launched by the powerful technology vendors (such as IBM, Amazon and Google) together with the strategic consulting companies, has played and will play a crucial role in the incremental implementation of such technologies.

4.1 Qualitative analysis on Artificial Intelligence implementation.

4.1.1 Companies selection and methodology.

The aim of this paragraph and of the following ones is to show the results of a Qualitative Research on the Artificial Intelligence implementation by Italian manufacturing companies, and of the related implications in term of growth potentials and criticalities.

[51] http://www.ilfriuli.it/articolo/economia/intelligenza-artificiale-per-la-manifattura-del-futuro/4/196798

This Qualitative Research was carried out by the undersigned under the supervision of the Professor Bettiol - from the Department of Economic and Business Sciences "Marco Fanno" of the University of Padua.
The analysis carried out by the undersigned involves a group of five Italian manufacturing companies:

- *BELLINI Spa*: it is a company located in Zanica (BG) that develops, produces and markets fluids in order to support the industrial processes; in particular cooling lubricant for metalworking productions.

- *UNOX*: it is a company located in Cadoneghe (PD) that produces and sells professional ovens, and in general it provides services to all food cooking businesses like: canteens, hotels and supermarkets.

- *SEA Vision*: it is a company located in Pavia (PV) which aims to carry out quality checks on pharmaceutical packaging lines; it is able to make every “visual” check on the pharmaceutical packaging chain.

- *SPEA Spa*: it is a company located in Volpiano (TO) that produces machines that are used to test electronic boards, circuits and components. SPEA Spa deals with the mechanics, electronics and software necessary to control these machines.

- *PROCEMSA Spa*: it is a company located in Nichelino (TO) that offers services in the production of food supplements, and that package in a dedicated department the products based on probiotics.

The aforementioned companies have been selected within the *Champion companies* that have declared – in a research made by the Department of Economic and Business Sciences of the University of Padua - that they use technologies associated with Artificial Intelligence.
The *Champion companies* are 500 companies with a turnover between 20 and 120 million that in the darkest years of the crisis - between 2010 and 2016 - instead of going into trouble, have begun to grow, and to produce profits and jobs.
This analysis allow to discover “unknown” companies with a high average growth of the last six years - which was at least 7% per annum (ie at least 50% over six years) - and with a high

gross profitability - which was at least 10% a year in the last three years (with an average of the sample exceeding 19% per annum) [52].

Therefore, in the research carried out by the University of Padua through the Digital Manufacturing Laboratory with the collaboration of ItalyPost, it appears that among the *Champion companies* only the five previously listed (*BELLINI Spa*, *UNOX*, *SEA Vision*, *SPEA Spa* and *PROCEMSA Spa*) make use of Artificial Intelligence.
Hence, these five companies have been selected as the "group" to be analyzed for the development of my *Qualitative Research* in the implementation of Artificial Intelligence in Italian manufacturing.

The contact with companies took place following three steps:

- sending the e-mail containing the request for collaboration and a general explanation of the research aim;

- telephone call with the human resources managers for an in-depth interview concerning the topics to be discussed during the research phase and on the aims of the latter;

- face-to-face or skype interview with the company responsible of the application and use of Artificial Intelligence within the corporation.

After the second phase – that involves the interview with human resources managers - all the companies agreed to continue with the interview regarding the application of Artificial Intelligence, with the exception of *PROCEMSA Spa*, which stated that it was not interested in take part in this research project.
Hence, I made a direct interview to four companies that are those which decided to take part to this research project: *BELLINI Spa*, *UNOX*, *SEA Vision* and *SPEA Spa.*

I realized, under the supervision of the Professor Bettiol, a general questionnaire with the aim of having a guideline to follow during the conversation with the responsible of the application of Artificial Intelligence in the company.
The key points of the questionnaire are the following:

[52] https://www.italypost.it/le-500-imprese-champion-vinto-la-crisi-competono-sui-mercati-globali/

- Briefly description of the activity of the company, its products and its reference market.

- Analysis of the business area in which the company is using the Artificial Intelligence.

- Defining the reasons way the company decided to invest in the Artificial Intelligence.

- Analysis of the main results that the company get from Artificial Intelligence usage.

- Understanding if the introduction of Artificial Intelligence led to internal organizational changes.

- Analysis of the importance of the internal competences in the adoption of Artificial Intelligence within the company.

- Understanding how Artificial Intelligence is handled within the company.

- Understanding if there is a team dedicated to Artificial Intelligence management and how many people it is composed of.

- Understanding how much the company invest in innovation every year.

- Analysis of the changes in the relations with the company's client, suppliers and supply chain in general due to the introduction of Artificial Intelligence.

- Understanding if the company has benefited from the past investments in ICT (management software, website, social media, e-commerce, digital infrastructure of the company, etc.) for the subsequent implementation of Artificial Intelligence.

- Understanding if the company has received or at least requested government incentives for the implementation of Artificial Intelligence technologies.

4.1.2 Qualitative Research

The purpose of the following paragraphs is the one of evaluating the different approaches to the Artificial Intelligence implementation by the four companies being investigated, in order to be able to analyze the growth potentials and criticalities of this innovative technology.
The interviews have been done by the undersigned in two ways: face-to-face or via Skype, on the base of companies' availability.

4.1.2.1 BELLINI Spa

The Qualitative Research concerning *Bellini Spa* has been done through an interview and discussion with Mr. Foglieni - *Quality Assurance Engineer* of the company - considered as the main expert in the Artificial Intelligence implementation within the company (entire interview visible in *Appendix A*).
Bellini Spa develops, produces and markets fluids to support industrial processes; in particular cooling lubricant for metalworking productions.
The company is located in Zanica (BG) and it is present in 24 countries, where retailers share the corporate policy and culture, and which are constantly updated with frequent training course.
Entering into the world of Artificial Intelligence, the *Quality Assurance Engineer* of the company said that it is mainly used in the **Operation and Logistic areas.**
Bellini Spa is also very active in the IoT and sensor area, as well as in programming via PLC (Programmable Logic Controller). In the future, it would like to explore a sort of "integrated logistics": it involves the integration of each step, both with the planning and control phases.
The integrated logistics, in addition to dealing with everything related to traditional logistics, is also connected with the production, marketing and all other departments.
In *Bellini Spa* the fundamental role of AI is to make all the various tasks more accessible and "talking", in order **to simplify the learning process of the single base operator (worker)**; this makes possible **greater workforce interchangeability**, thanks to **less dependence on the single human resource.**
In addition, Artificial Intelligence plays a key role in **increasing the quality of the process**, which translates into better performance at the production level. The best performance derives from the higher speed and lower costs, guaranteed by the application of Artificial Intelligence.
Concerning the application of Ai within the Operation area, Mr. Foglieni said that Artificial Intelligence is exploited directly on production plants. The company is launching a new project.
Related to this new project, Mr. Foglieni said that:

“previously the operator had a "recipe" on a paper sheet and he/she had to set all the drafts of the machinery following those indications.
Nowadays, through this Synoptic PLC, we are implementing a revolution that will allow us directly from the formula associated with the single order, to load the list on the system onto the PLC and then automatically carry out the draft. There will no longer be the manual entry of the bill by the operator, but this will be limited to printing the order and reading it through a BARCODE gun, thanks to which all the data will be imported on PLC. The operator will check to see that everything will be in order and the process will be started automatically, thus **increasing the stability and quality of the process**; but also speed: with a BARCODE gun reading, **you can avoid about thirty manual operations previously done**.”

For *Bellini Spa* assessing the impact of AI on sales is not easy, because the company's turnover has grown from six years in a double digit, around 13-14% per annum.
It has gone from a turnover of 13 million in 2011 to one of almost 29 million in 2018.
For this reason, it's not easy to understand how much the push is given by investments made in Artificial Intelligence, how much by research and development and how much by the commercial network. Surely the whole has been fundamental, but during such a strong growth phase it is difficult to identify the impact of every single component in the final result.

Bellini Spa has started implementing the Artificial Intelligence in 2017.
The Quality Assurance Engineer identifies *three main difficulties* encountered in the introduction and management of the AI:

- from managerial point of view, the main difficulty faced by the Bellini Spa has been to make the operator understand its role. It has been complex, according to Mr. Foglieni, to show to the workers that **the role of Artificial Intelligence is not the mere replacement of the operators, but it is mainly a help and a support to their work.**

- the **upstream design of the AI project** has been identified, by the Quality Assurance Engineer, as a further problem. In fact, It is not easy to identify the company's needs and requirements in terms of AI and to match them with what the market offers.

- it has been difficult putting in place the solution defined as ideal.

Concerning the management of Artificial Intelligence, the *Bellini Spa* has not an ad hoc department with the aim of controlling and guiding the AI. The company is a SME of around 55 employees, so it has no possibility to dedicate a team entirely to the management of the AI. In fact, there are two people – from the Quality Assurance Engineering team - designated to manage Artificial Intelligence, but not full time; **AI management is based on project activities that they follow alongside their daily tasks.**

Source: https://www.european-business.com/bellini-spa/portrait/

The introduction of the AI has not changed the relationship of the company with its supplier but it has partly modified the relation with customers. The company introduced a new order receipt tool in the Sales area, partially based on AI technology; this allows the customer to directly send the order and the various orders through a web portal, and not anymore through the usual email.

The company has unified most of the entry orders on this portal avoiding entry errors; in fact, the greater the data transfer the greater the probability of error.

This tool has allowed the company to gain much more efficiency, as well as effectiveness, thanks to the reduction in the number of errors.

In the future, the company has the intention to improve the role of AI in the Operation area.

In fact, it would like to use Artificial Intelligence also to get real-time data on the need to perform extraordinary maintenance on production facilities. **It means moving from a reactive maintenance to a preventive maintenance.**

According to Mr. Foglieni, the investments made in the past few years in the world of Industry 4.0 facilitated the implementation of Artificial Intelligence.
In fact, those investments in 4.0 technologies represented an important breaking point between the past and the future, which opened the "company eyes", showing what can be achieved with the use of Artificial Intelligence with respect to the more traditional conduct of the activities.
The role of data, as analysed in the previous chapters, remains crucial for AI implementation.
In fact, Mr. Foglieni said: "in order to use Artificial Intelligence, **we are also much more careful in data management.** To store, process and divide the data we have introduced several panels, based on software. These panels are used for data monitoring and Business Intelligence activities dedicated to each department".

Another relevant problem that the company faced was related to the internal skills, that were sufficient to manage the implementation of Artificial Intelligence.
The company has been assisted, in the management of AI, by suppliers and external consultants; it has been necessary in order to acquire the skills that the company initially did not have.
Furthermore, according to Mr. Foglieni, this experience was also useful to enrich the skills of all the company function heads.
So, the company had a support in implementing the AI. In particular these coaching activities involved individual processes. After two years the company is quite autonomous.

Concerning the internal organizational changes, it is necessary to highlight that the introduction of Artificial Intelligence has involved the movement of personnel from some departments to others.
There was a process of "re-expansion" of some figures, that were previously required in specific departments but, due to the introduction of Artificial Intelligence and automation, they were no longer necessary in that specific area.
However, according to Mr. Foglieni, no one was taken out of the company.

4.1.2.2 UNOX

The Qualitative Research concerning *UNOX* has been done through an interview and discussion with Mr. Cammarota – *Research Manager* of the company – which had an important role in the implementation of Artificial Intelligence within the company (entire interview visible in *Appendix B*).

Unox is a company that produces and sells professional ovens, and generally provides services to all businesses that deal with cooking world, from the small restaurant that needs an oven to satisfy just a few seats, to large chains like McDonald's and Subway; passing through canteens, hotels and supermarkets.
The company is located in Cadoneghe (PD) and it has about 690 employees, of which around 200 are in Italy, where the company is focused on the Operation and Innovation areas.
While, abroad, the company is more focused on Sales.
Within *UNOX*, the Artificial Intelligence is present in two areas: **in the Research area and in the IT area**.
In the IT area, Artificial Intelligence is mainly used in the field of *Business Intelligence*.
Almost all the company products are connected to the internet, and, as an incentive, Unox provides 4 years warranty to the customers who decide to connect their oven to the internet.
The internet connection is fundamental for the company in order to gather all the information that the oven records and measures:

- data on the temperatures of the components, that allow the company to do diagnostics and maintenance in a predictive manner

- usage data that allow the company to create insights to give to its customers to use the oven at its best.
  Mr. Cammarota made the following examples: “the combi-oven, which is our flagship product, is capable of cooking with both hot air and steam convection; if we see that one of our customers does not use, for example, the steam function, we send him an email and a notification on the app saying that the oven is able to carry out different types of cooking and we suggest also a potential recipe.
  The consumer, by telephone, can send the recipe to the oven and try the steam recipe.
  Another case could be the one in which the customer uses the oven only during the day, in which case we communicate to the customer the possibility of expanding his business thanks to the possibility of making a night cooking in total autonomy.”

This data analysis and advice generation, aforementioned, is done in the *IT area* of the company.
In the *Research area* the company is working on hardware technologies, such as the *machine vision*, which is a system that allows the oven, with the use of a camera, to automatically

recognize the food that is inserted and therefore autonomously launch the right cooking program and understand the degree of cooking of the food.
The company is also working on *voice control technology*, which uses technologies that are in the world of Machine Learning and Deep Learning and therefore fall within the Artificial Intelligence environment.

Unox have been working on Artificial Intelligence from 2016, and during these years - according to Mr. Cammarota –the company faced the *following difficulties* in the AI introduction and implementation:

- the greatest difficulties encountered by the company is related to the **paradigm shift** needed to bring Artificial Intelligence into a "mechanical" company.
  In the past the company was only looking for mechanical engineers; nowadays, instead, it is looking for workers able to use these innovative technologies.
  Looking also at *Unox* workforce, in the past the Innovation area was at 99% composed of mechanical engineers; nowadays it is composed of approximately an equal number of mechanical engineers and other profiles able to exploit the technologies of the future. Often these profiles have a Data Science Master Degree.

- Another problem that the company has had to face concerns the difficulty in finding personnel capable of exploiting the technologies of Artificial Intelligence.
  Nowadays, as the AI world is growing, finding staff has become easier.

Concerning the main results obtained thanks to the use of Artificial Intelligence, Mr. Cammarota said: “Unox has not yet "go out" on the market with products that heavily use Artificial Intelligence. We think, however, that this technology will lead us to an **important growth in terms of turnover**.
This market is a fairly conservative market, therefore quite resistant to changes; the main reason lies in the fact that the oven is the main production machine in the kitchen, so if the oven were to give problems it would be like blocking the production line of
a company.
Nevertheless, we believe that in a certain number of years **an oven that does not use technologies related to Artificial Intelligence will be totally obsolete and unsellable**.”

Source: https://www.hospitalitydirectory.com.au/product-news/12714-unox-head-office-on-site-training-kitchen/

Although Unox expects a growth in turnover, the investments made for the implementation of Artificial Intelligence have also been considerable, both in terms of **resources and time spent** – particularly in the Research area.

The introduction of Artificial Intelligence led also to **internal organizational changes**. In fact, this technology shifts the "centre of gravity" of the *skills* that are needed by a company.

The impact does not only concern the skills but also the *strategic resources*; translating it into Business Model Canvas terms, it means that **the key resources move in the Artificial Intelligence areas.**

Unox decided to invest in the Artificial Intelligence technologies because of a **market need**. Mr. Cammarota said: "everything comes from the need to make a product with certain characteristics; characteristics that can be present only through Artificial Intelligence. Unox is currently much more focused on this aspect, rather than making production processes based on 4.0 technologies.

Our product enters in our customer's production process, so making a AI product means giving our customer an AI production process".

The AI implementation generated also a **change in the relationship with the customer,** mainly related to the insights and coaching that the machine does to the customer. Unox has started to provide its customers, thanks also to Artificial Intelligence, a *digital experience.*

The company has also a team that develops the Unox App, which offer customers the opportunity to do “oven training” and to manage data driven cooking: in the app the client has all the data related to the oven usage. In this field, the Artificial Intelligence is present in the Machine Learning mechanisms that analyze data and provide insights to the customer.
On the **supplier side**, the change concerned the need to contact *external consultants or external bodies such as universities* (Unox did two hackathons on Artificial Intelligence in the University of Padua). The electronics suppliers, however, have not changed, but the company has begun to acquire more performing objects and with greater computing power.

Concerning the management of Artificial Intelligence, *Unox* has some employees involved in the control of AI, mainly in the Research, Software Engineering and IT team.
The following is Mr. Cammarota's comment on the role of past 4.0 investments in the implementation of the AI: “We have been investing in these instruments for a while now. The difference with the past is that now the most advanced equipment is available to everyone, something that did not happen in the past. For example, Google offers platforms, including Tensorflow, totally free and optimized for calculating neural networks.
Today's world provides us with everything needed for the application of these new technologies, what Unox had to do was **to create know-how, train people and create all the internal infrastructure to manage this type of project**.”

In the future, Unox could start using Artificial Intelligence also for the maintenance of production plants as well as ovens.
Currently, however, this type of maintenance leads to better results in *data driven sectors*, where it is possible to collect a quantity of data that gives a company the chance to carry out assessments and analysis even in the maintenance field.
On the contrary, for what concerns oven production, which is a type of production mainly physical drive, it is considered more appropriate a maintenance that requires the "vision" and the direct work of the operator.
In fact, for example, the operator can check directly if the production standard is not followed.
As a result, Unox currently believe that “*manual maintenance” is more reliable.*

4.1.2.3 SEA Vision

The Qualitative Research concerning *SEA Vision* has been done through an interview and discussion with Mr. Pizzochero - *Business Intelligence Software Product* responsible for the company - considered as the main expert in the Artificial Intelligence implementation within the company (entire interview visible in *Appendix C*).

SEA Vision is in charge of carrying out quality checks on pharmaceutical packaging lines.

The company, using video cameras, is able to check, along the whole pharmaceutical packaging chain, that the drug is present, that it is intact, that it is of the correct shape and color, that the external packaging is undamaged and contains everything needed for market diffusion.

The company also check that the data printed on the package are the correct ones.

Furthermore, it is able to carry out every type of control that can be called "visual inspection": in addition to those already mentioned, it can check the fluid level inside the vial and the correctness of the data printed on the label applied to cylindrical containers (which therefore require more sophisticated machinery reading capabilities).

Another big chunk of *SEA Vision* business that concerns the *serialization*.

Regulations at European and world level require complete traceability of the drug along the entire supply chain. It is therefore necessary, starting from the pharmacist, to go back up the entire supply chain to the producer. This is essential to fight the phenomenon of counterfeiting.

Counterfeiting does not have an economic impact only, but it also has the crucial problem linked to consumer health: at best a counterfeit drug does not produce the desired effect, at worst it produces results that are even harmful to the patient's health.

To avoid these problems, *SEA Vision* has developed a systems for the serialization of the drug, known as *"tracken phase"*, which is able to trace every single package of medicine.

For the company, the Artificial Intelligence plays a crucial role in all the activities abovementioned.

The introduction of the latest regulations, at national level, related to Industry 4.0, has allowed the company to base its business on these new technologies.

In fact, important tax breaks have been envisaged (as shown in the *paragraph 2.5*) for those who have followed the "industry 4.0" criteria: among these, the ones exploited by SEA Vision are:

- to control the machineries through a control software.
- to gather the data, analyze and exploit it in order to make *forecasts* thanks to the use of Artificial Intelligence.

The control of machineries through software is an activity that *SEA Vision* has been doing for some time; instead it has recently started using Artificial Intelligence to analyze the data coming from the machinery and to make forecasts.

In practice the company has created an AI software able to control the machines and acquire the data during their operation throughout the day, in order to be able to exploit the data to perform different operations.

According to Mr. Pizzochero, the main *SEA Vision* aim is to fully exploit the Artificial Intelligence for data collection and analysis.

For every business, but in particular for the SEA Vision one, the **data collected by the machinery has a very high value**, therefore managing it in the appropriate manner is fundamental.

When during the process of *visual inspection* or *serialization* of the drug the machinery follows incorrect behaviors and does not respond as expected, it is necessary to understand the causes of these problems in order to provide a solution.

Within *SEA Vision*, the AI uses the data collected by the machineries to create reports, which are **essential to understand what happened**. Subsequently it analyzes the collected data and extracts information **to predict what will happen in the future**, analyzing how the systems behaved.

Finally, Artificial Intelligence has the fundamental role of intervening in the face of **unexpected machine behavior** and **correcting it** in order to follow the correct process line.

In summary, the role of the Artificial Intelligence for *SEA Vision* is the one of **data collection and analysis, realization of forecasts and corrective actions** in case of unexpected attitudes.

However, for SEA Vision, the Artificial Intelligence implementations is still in the research and development phase.

According to Mr. Pizzochero, the *main problems* in the application of such advanced technology are:

- the **lack of vertical skills to fully manage it**. SEA Vision does not have such expertise within the company, so they have to train the workers.

- Furthermore, it has been very difficult, for the company, to find personnel with the skills necessary to manage these technologies. It therefore had to turn to **external companies** that make the management of such advanced technologies their core business.

Source: https://www.polimerica.it/articolo.asp?id=19332

Concerning the internal organizational changes after the AI implementation, Mr. Pizzochero said: “the introduction of Artificial Intelligence certainly did not have a negative impact within the company, not even as regards the number of employees. Usually in almost all companies that bring such radical innovations as this, especially in the core business, many employees are then left at home, but this was not the case for us.
Instead it has had a positive impact for us: **it is a new slice of business and therefore we had to hire and we are still hiring new staff with advanced skills related to the AI world**.”

In addition, according to Mr. Pizzochero, the main reasons that led the company to invest in Artificial Intelligence is the business itself - as always happens talking about "for profit" companies.
There was a business need, in addition to the fact that *SEA Vision* customers ask them for these innovations. It is important to underline that not many of *SEA Vision* competitors offer this service.
This company is not a research institution, nor a non-profit organization, so the choice to implement the AI **followed the logic of creating income**.

Even if, at this stage, the process is not yet fully mature, some results are already visible.
The main one is the strong interest generated among the company’s customers and potential customers.

The growing interest in these issues led to a growing interest also in *SEA Vision* product.
According to Mr. Pizzochero, to talk about "numbers" on the market it is still a little early, but there are prospects for a growth also in terms of turnover.
Concerning the changes in the relationship with the company suppliers and customers, after the AI implementation, Mr. Pizzochero said: "on the supplier side, the implementation of this new technology has not brought relevant changes.
The main changes, on the other hand, concern the customer who, in any case, had **to partly adapt to the new technology** adopted by *SEA Vision*.
The role of data collection is crucial, therefore it is necessary that the customer also exploits partly compatible technology with ours. As I said earlier, the main impact was neither in relation to the customer nor in relation to the supplier, but mainly in the search for sufficiently skilled personnel."

SEA Vision benefited also of the past investment in others Industry 4.0 technologies; in fact, they certainly helped the company in **creating a mindset** that facilitated the introduction of a more radical innovation such as Artificial Intelligence.

4.1.2.4 SPEA Spa

The Qualitative Research concerning *SPEA Spa* has been done through an interview and discussion with Mr. Tamburini – *Financed Research Manager of R&D Department* – which had an important role in the implementation of Artificial Intelligence within the company (entire interview visible in *Appendix D*).
First of all, it is important to underline that *SPEA Spa* activity does not involve the practical application of Artificial Intelligence systems in production processes, but what the company does is a **fundamental link in the chain of development of cognitive systems** based on data deriving from different sources. In particular the company works on any type of sensor.
SPEA Spa produces machines that are used to test electronic boards, circuits and components. The company deals with the mechanics, electronics and software necessary to control these machine; it also manufactures machines to test components and devices that its customers need to produce the "technologies of the future".
To make the activity carried out by SPEA Spa clearer, Mr. Tamburini made the following example: "if you take into consideration a latest-generation mobile phone, within it you will find two to five cameras, pressure sensors, humidity, temperature, compasses, microphones,

light and proximity sensors. All these sensors are manually integrated into one or more electronic circuits that are tested one by one, not only to be certain of their operation, but also to assess whether they respond to the physical stimulus for which they were designed. For example it is important to check that an accelerometer feels the force of gravity and so on.

All these devices are tested one by one. Consequently, when our customers need to create these new generation devices, they know that one of the fundamental steps of the overall process is to test the device and the sensors that characterize it.

So, the companies that design new-generation devices come to us to test it."

Source: https://www.spea.com/it/board-testing-house-it

All the SPEA Spa activities are therefore linked to the Artificial Intelligence.

In fact, for example in the world of telephony, the next-generation mobile phones will have microphones that, based on intelligent software, will be able, in a concert, to isolate the singer's voice from all the noise of the crowd. Consequently, to do this, it is necessary that the software is able, **autonomously and intelligently**, to recognize the different frequencies of the various sounds.

Many of SPEA Spa customers are already doing projects in this field. If these phones were to go out in two to three years, the realization process must begin now. The process of "testing" is also part of the process.

Another example could be referred to the autonomous driving. The completely autonomous driving is entirely based on **systems that are able to replace the typically human abilities in the interaction with the surrounding environment.** For this reason, it is essential that the

system is able to make the appropriate decisions based on information that are obvious to humans, but that for a cognitive system are not. For example, a human who sees a yellow school-bus knows that he must increase attention because a child could cross the road by surprise, which is not obvious for a non-human system.

So, if on one hand an intelligent system is able to identify an obstacle and brake with a *reaction time* lower than the human one – hence, the level of trust on this aspect can be very high - on the other there is a whole world in which the interpretation of the human brain is much more complex to be replicated by a cognitive algorithm.

The idea of the self-driving car of the near future, with intelligent cognitive systems that simulate and emulate human intelligence, is based entirely on sensors.

SEA Vision has the aim to test all these sensors one by one, especially when safety is at stake.

If, with the mobile phone, the reliability of the sensor has an impact at the brand image and market level, with the self-driving car the reliability of the sensor is crucial for the life of the individual.

All *Artificial Intelligence systems* pass from *sensors* that provide to the system the information that man provides through the senses; all these sensors must be tested to ensure that they respond to the physical stimulus for which they were designed.

It is precisely in testing the various sensors the *SPEA Spa* relationship with the world of Artificial Intelligence.

The company produces a system that tests a sensor by creating a machine capable of handling the greatest possible number of sensors in the shortest possible time in order to reduce the cost of the test.

Hence, the *SPEA Spa* does not make direct use of Artificial Intelligence, but provide services to its customers that allow them to produce systems based on *cognitive solutions* and *Artificial Intelligence.*

Most of these intelligent software are characterized by **self-learning systems**, so **they continue to "learn" even after being put on the market**.

The work done by Google Home is possible because the microphone integrated in it must be able, during the reproduction phase as a speaker, to recognize the individual who says "ok Google"; then it has to stop the playback and "listen" to the input of the individual.

This type of microphone is an electronic component that must be tested with *SPEA Spa* machines and, in order to give the consumers the chance to use it optimally, it is necessary to find and invent the best way to test this device so that it responds exactly to what it needs to do. It is therefore necessary to create a machine that replicates reality in the most "faithful" way possible.

A fundamental aspect for a company like *SPEA Spa* is the test time of a device, which may vary slightly depending on the physical stimulus to which it must be subjected, but that is usually of a few seconds. Hundreds sensors are tested in parallel, so the time per component is extremely low, in the order of milliseconds. If a component is defective it is thrown away, because the reworking cost is higher than the production one.
SPEA Spa goal is to test the sensors as quickly as possible.
It is necessary to test the components because the manufacturer cannot afford to send non-functioning sensors to the market.
The test, however, from the point of view of those who produce machinery, **is a pure cost, as it does not add value to the final product**; if this had already been a perfectly functioning product during the production phase, the test would not have been necessary.
Consequently, the requirement by SPEA Spa customers is that the cost of the test as to be as low as possible; in order to satisfy this requirement, it is necessary that the test time is as low as possible.
The test is therefore an integral part of the production process but must not create a bottleneck.
According to Mr. Tamburini, the main challenges of SPEA Spa towards its competitors, in order to get a customer, are: the *test time* and *reliability*.

The company - to purchase of the equipment needed to perform these tests - benefited of the government incentives related to the Industry 4.0.
Mr. Tamburini said “the company benefited of the government incentives in two sizes: both with the purchase of equipment that we need for the realization of our machinery, and for the “realization in economy” of machinery produced by ourselves. For the production of our machines we need other machinery; also on this we have benefited from the incentives on Industry 4.0.
Our machines have all the features required: system connectivity, sensorization and remote-control systems.”

For a company like SPEA Spa, **the biggest cost item in its budget is the staff cost**.
The company produce a machine for testing a single type of sensor, therefore the level of customization required is very high. For this reason, it is therefore necessary to have several design teams in parallel, which realize extremely diversified projects.

Concerning cost impact, Mr. Tamburini said: “the biggest cost item in our budget is the cost of personnel. Ours sector is in continuous expansion, so we also need an extremely large sales force from the point of view of commercial relations: the company has over 800 employees.
As the second main item of cost I would say the purchase of raw materials, because our business is part of the metalworking industry.”

4.1.3 Comparative Analysis on the Qualitative Research

After the case by case analysis of the different Artificial Intelligence’s adaptation and implementation methods - by the companies being studied -, in order to have an overall picture of the theme it is necessary to do a *comparative analysis*.

First of all, to identify those that could be defined as the "*criticalities*" in the implementation of Artificial Intelligence, it is necessary to combine the various difficulties reported by the companies in the research phase shown in the previous paragraphs.

These are the main difficulties highlighted:

- **to make the operator understand the role of Artificial Intelligence.**
  In fact, its role is not the mere replacement of the operators, but it is mainly a help and a support to their work.
- the **lack of vertical skills to fully manage the AI**. A lot of Italian manufacturing companies – although highly developed from a technological and innovative point of view - does not have enough AI expertise within the company, so they have to train the workers.

- **to find personnel with the skills necessary to manage these technologies**. The company therefore had to turn to **external companies** that make the management of such advanced technologies their core business.

- the **upstream design of the AI project**: to identify of the company's needs and requirements in terms of AI and to match them with what the market offers. Furthermore, once identified the AI the solution defined as ideal, it is difficult to put it in place

- the need to make a **paradigm shift** in order to bring the Artificial Intelligence into an Italian manufacturing company.

Among the main problems reported by companies, what appears to be crucial are: the operator's lack of skills and the difficulty in finding personnel capable of using this technology.
This problem can also be defined as the ***paradox of Artificial Intelligence***: in fact, this technology was born with the primary aim of helping, supporting and in the extreme case replacing human work, but, as a result of the analysis **it remains dependent on the individual**. Human labor is therefore crucial in the implementation and development of this technology.

To solve this problem a lot of companies are developing a new business, acting as consultants in the implementation of advanced technologies such as Artificial Intelligence.
As pointed out in the Qualitative Research, three companies out of four needed to request the assistance of external bodies, in order to:

- offer training courses to workers;
- assist top managers in developing AI projects;
- support the technical personnel in the application of the AI.

From the Qualitative Analysis, obviously, have been highlighted - in the implementation of the AI technology - not only criticalities, but also strengths, which can guarantee relevant growth opportunities to the “adopting companies”.
The main *common benefits* pointed out by the companies being analyzed are the following:

- **to simplify the learning process of the single worker** because the tasks become more accessible. This makes possible **greater workforce interchangeability**, thanks to **less dependence on the single human resource.**

- to control the machineries through a control software.

- To collect data and to create reports, which are **essential to understand what happened in case of machine breakage**.

- to extract information in order **to predict what will happen in the future**, analyzing how the systems behaved.

- **to increase the quality of the process** and to improve the performance at the production level.

- to face **unexpected machine behavior** and **to correct it** in order to follow the correct process line.

- to get real-time data on the need to perform extraordinary maintenance on production facilities. **It means moving from a reactive maintenance to a preventive maintenance.**

Even if the companies being analyzed did not want to report the monetary investments needed to implement the AI - as it is considered a confidential information –, they, nonetheless, stated that the choice to invest in such advanced technology is expensive both in resources and time spent.
In particular, as stated by the *Financed Research Manager of R&D Department* of SPEA Spa (a firm that offers support services to companies that want to develop projects related to the AI world) the companies, when choosing AI sensors testers, pay mainly attention to the cost (which is connected to the time required for the test) and to the reliability of the service provider.
However, the companies analyzed declared that they had obtained important benefits from the AI investment, particularly related to:

- relevant growth in terms of turnover.
- growing interest in the stakeholders' side.
- government incentive and tax benefits.

All the companies have also stated that a previous investment in Industry 4.0 technologies has brought significant simplifications in the subsequent implementation of Artificial Intelligence projects.
In particular, these benefits are relater mainly to the operators' "change of mentality": they have to cohabit with this new technology; therefore, it is essential that they accept it.
Hence, as highlighted by the Qualitative Research, it is advisable to opt for a *gradual AI introduction process*; preferably after having tested the impact of other technologies related to the Industry 4.0 world.

The results of this Qualitative Research emphasize that the introduction of such advanced technology cannot be done abruptly; if a company overnight decided to switch from a purely craft-production to an AI-based one, it would almost certainly fail to complete its objectives.
The decision to opt for the AI implementation must therefore go through a process of technological evolution, which could take years.
As said previously, all the companies subject to the Qualitative Research, despite their business being almost entirely based on advanced technologies, have been accompanied by external bodies in the introduction of the AI; this demonstrates the complexity of the technology being studied and the necessity to work hard for a long time in order to obtain the desired results.

CONCLUSION

Nowadays, the number of Italian manufacturing companies that have decided to opt for the Artificial Intelligence implementation is still very limited, even if the growth prospects are not lacking.

Companies that would like to implement this type of technology must be able to cope with the workforce reluctancy and the top management fear to rely on a non-human entity able to replicate and replace human work.

In the Italian manufacturing world, where quality is the driving force, it is essential to produce efficiently. The Artificial Intelligence can be crucial in increasing the productive *efficiency* and *effectiveness* of a company, mainly due to its ability to overcome the discretion of the individuals, trying always to do the best thing possible.

Obviously - as shown in the *Qualitative Analysis* set out above - the role of the individual is fundamental even in presence of AI.

Like any radical change within a company, the AI introduction will obviously lead to personnel movements; hence, it will be essential for companies to relocate the staff in the appropriate manner.

The key to success for a company will therefore be to entrust every worker with a new role that should be, on one hand supportive and, on the other, supported by the Artificial Intelligence.

It is necessary to underline - as demonstrated by a study carried out by the *Artificial Intelligence Observatory* of the School of Management of the *Politecnico di Milano* - that Italian manufacturing companies have currently invested meager expenses in the Artificial Intelligence implementation, showing a weak level of trust in this technology; however, in the next 15 years, the number of companies that will decide to include this technology in their business will grow exponentially.

In particular, as highlighted in the survey carried out by the *Artificial Intelligence Observatory* of Milan, in the next 15 years 3.6 million workers could be replaced by AI technologies, but in the same period, due to the increase in consumers' demand (thanks to the greater variety of products offered through the AI technologies) and due to the greatest need of specialized employees, is estimated to have a need of personnel of around 4.7 million people in the country, from which emerges a positive deficit of around 1.1 million jobs [53].

In this scenario, the AI appears not only as an opportunity, but as a necessity, in order to maintain the current levels of socio-economic well-being and to create new jobs with greater

[53] https://www.corrierecomunicazioni.it/digital-economy/intelligenza-artificiale-in-italia-mercato-agli-albori-ma-prospettive-da-boom/

value. It is necessary to underline, however, that the workers who will occupy the new jobs generated by the Artificial Intelligence will have different competences compared to the 3 million jobs that will be replaced by the AI; this means that there will be a strong cognitive differential between the workers who will be hired and those that, instead, will be replaced by the technologies of the future.

David Autor and Anna Salomons (2017) – in their paper called *"Does productivity growth threaten employment?"* – analyze how the risk of a productivity growth, following a technological evolution, could threaten employment.

Their analysis coincide with the results of my *Qualitative Research*, showing that the technological development tends to relocate medium skilled workers (who operate mainly in industrial production), generating a "polarization" of the demand for labor: on one hand, high-skilled workers who have to directly manage the advanced technologies (such as the AI); on the other, workers with limited capabilities who deal with all the "outline activities" that are necessary for the company functioning but which do not come into contact with the technological world. Thus, the technological growth does not diminish the aggregate demand for labor but polarizes it on the basis of the preparation of workers.

This means that, in the near future, the presence of Artificial Intelligence technologies could lead to a net reduction in the medium skilled workforce requirements, keeping the presence of limited skilled personnel unchanged and strongly increasing the demand for high accomplished workers.

The main aim of this thesis is to demonstrate that, despite the undoubted Artificial Intelligence limitations, the opportunities and potential of the latter are significant.

The AI growth potentials are not currently fully expressed, but they will play a key role in the future of the Italian manufacturing business.

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Last sites view: 14th September 2019

APPENDIX

Appendix A (English Version):

Interview with Mr. Foglieni, Bellini Spa.
Mr. Foglieni's role*: Quality Assurance Engineer*

Paolo: Can you briefly describe the activity carried out by Bellini Spa, its products and the reference market?
Dott. Foglieni: Bellini Spa develops, produces and markets fluids to support industrial processes; in particular lubro-refrigerants for metalworking productions.

Paolo: Entering into the world of Artificial Intelligence, how and in what area of the company is it mainly used?
Dott. Foglieni: Artificial Intelligence is mainly used in the Operations area and also in Logistics. We are also very active in the IoT and sensor area, as well as in programming via PLC (programmable logic controller) interconnected to our servers. In the future we would also like to explore a sort of integrated logistics.

Paolo: How, in a practical way, is Artificial Intelligence used? What is the main role of Artificial Intelligence in your business?
Dott. Foglieni: The fundamental role is to make all the various tasks more accessible and "talking", in orde to simplify the learning process of the single base operator; this makes possible a greater interchangeability, thanks to a lesser dependence on the single human resource.
In addition, Artificial Intelligence plays a key role in increasing the quality of the process, which translates into better performance at the production level. The best performance derives from the higher speed and lower costs, guaranteed by the application of Artificial Intelligence.

Paolo: You told me that Artificial Intelligence is used mainly in the Operation area. Can you give me more information about this?
Dott. Foglieni: Artificial Intelligence is exploited directly on production plants. We will launch a new project in a month. In the past the operator had a "recipe" on a paper sheet and had to set all the drafts of the machine following those indications. These drafts made heavy

additions to the quantities that were grafted into the mixer, to then make the finished product by mixing. Today, through this SYNOPTIC PLC that interfaces via a sequel bridge, we are implementing a revolution that will allow us directly from the formula associated with the single order, to load the list on the system onto the PLC and then automatically carry out the draft. There will no longer be the manual entry of the bill by the operator, but this will be limited to printing the order and reading it through a BARCODE gun, thanks to which all the data will be imported on PLC. The operator will check to see that everything will be in order and the process will start automatically, thus increasing the stability and quality of the process; but also the speed: with a gun reading BARCODE you can avoid about thirty manual operations done previously.

Paolo: Thanks to the use of Artificial Intelligence you have achieved important results in terms of speed and quality of the process. And in terms of turnover?
Dott. Foglieni: Assessing the impact of AI on sales is not easy, because Bellini Spa's turnover has grown from six years in a double digit, around 13-14% per annum. It has gone from a turnover of 13 million in 2011 to one of almost 29 million in 2018. So it's not easy to understand how much the push is given by investments made in Artificial Intelligence, how much by research and development and how much by our commercial network.
Surely the whole will have been fundamental, but growing so much it is difficult to identify the impact of every single component in the final result.

Paolo: How long have you been using Artificial Intelligence and what difficulties have you encountered in introducing it into the company?
Dr. Foglieni: We started using it in 2017, so about two and half years ago. The main difficulty encountered in the introduction and management of Artificial Intelligence, from a more managerial point of view, was to make the operator understand its role. It has been complex to show the worker that the role of Artificial Intelligence is not the mere replacement of the operator, but is mainly a help and a support to their work.
A further problem, obviously, was that of the upstream design: it is not easy to understand what our requirements in terms of AI are and to match them with what the market offers. Even putting in place the solution defined as ideal is not simple, but I confirm that the greatest difficulty encountered was in the communication with the operator.

Paolo: Do you have a department dedicated to the management of Artificial Intelligence?

Dott. Foglieni: No, in our company there is no ad hoc department dealing with the management of Artificial Intelligence. My colleague and I deal with it, in particular on the Operation part. We are an SME of around 55 employees, so it would not be possible to dedicate a figure entirely to the management of the AI.
AI management is based on project activities that we follow alongside our daily tasks.

Paolo: Has the introduction of Artificial Intelligence changed the relationship with your suppliers and customers in any way?
Dott. Foglieni: Partly in the customers' side. We have introduced a new order receipt tool in the Sales area; this allows the customer to directly send the various orders through a web portal, and not anymore through the usual email. We have unified most of the entry orders on this portal avoiding entry errors; in fact, the greater the data transfer the greater the probability of error. And of course, this has helped us in time saving.
This also allowed us to gain much efficiency, as well as effectiveness, thanks to the reduction in the number of errors.

Paolo: In the Operation area, did you use Artificial Intelligence also to get real-time data on the need to perform extraordinary maintenance on production facilities?
Dr. Foglieni: Not yet, it is an idea that we intend to develop in the future, but is currently not in operation.

Paolo: Have the investments made in the past few years in the world of Industry 4.0 facilitated the implementation of Artificial Intelligence?
Dott. Foglieni: Yes, certainly. It was an important breaking point between the past and the future, which opened our eyes, showing what can be achieved with the use of Artificial Intelligence with respect to the more traditional conduct of the activity.
To use Artificial Intelligence we are also much more careful in data management. To store, process and divide the data we have introduced several panels, using software. These panels are used for data monitoring and Business Intelligence activities dedicated to each department.

Paolo: Were your internal skills sufficient to manage the implementation of Artificial Intelligence?
Dott. Foglieni: No they were not enough. We have been assisted, in the management of AI, by suppliers and external consultants; this was necessary to acquire the skills that we initially did not have. This experience was therefore also useful to enrich our skills.

Paolo: Have you therefore had a general support in implementing the AI?
Dr. Foglieni: We have been side by side, but not in the whole business. The coaching involved individual processes. Now we have become quite autonomous.

Paolo: Has the introduction of Artificial Intelligence led to internal organizational changes?
Dott. Foglieni: Yes, the introduction of Artificial Intelligence has involved the movement of personnel from some departments to others. There was a process of "re-expansion" of some figures who were previously required in specific departments and who were no longer needed in that specific task, for the introduction of Artificial Intelligence and automation.
However, no one was taken out of the company.

Interview made by Paolo Inì.
Department of Economics and Business Sciences "Marco Fanno" - University of Padua.

Appendix A (Italian Version):

Intervista Dott. Foglieni, Bellini Spa.
Ruolo Dott. Foglieni: Quality Assurance Engineer

Paolo: Può descrivere brevemente l'attività svolta dalla Bellini Spa, i suoi prodotti e il mercato di riferimento?
Dott. Foglieni: In estrema sintesi La Bellini Spa sviluppa, produce e commercializza fluidi a supporto dei processi industriali; in particolare lubro-refrigeranti per produzioni metalmeccaniche.

Paolo: Entrando nel merito del mondo dell'intelligenza artificiale, in che modo ed in che area dell'azienda viene principalmente utilizzata?
Dott. Foglieni: L'intelligenza artificiale viene principalmente utilizzata nell'area delle Operations ed anche in Logistica. Inoltre siamo molto attivi nell'area di IoT e di sensoristica, oltre che nella programmazione tramite PLC (programmable logic controller) interconnesso ai nostri server. In futuro vorremmo sondare anche una sorta di logistica integrata.

Paolo: In che modo, in maniera pratica, viene sfruttata l'intelligenza artificiale? Qual è il ruolo principale dell'Intelligenza Artificiale nella vostra attività?
Dott. Foglieni: Il ruolo fondamentale è quello di rendere più accessibili e "parlanti" tutte le

varie mansioni, in maniera tale da semplificare il processo di apprendimento del singolo operatore base(lavoratore); questo rende possibile una maggiore intercambiabilità, grazie ad una minore dipendenza dalla singola risorsa umana.
Oltre a ciò, l'intelligenza Artificiale gioca un ruolo chiave nell'aumentare la qualità del processo, che si traduce in una migliore performance a livello produttivo. La miglior performance deriva dalla maggiore velocità e dai minori costi, garantiti dall'applicazione dell'Intelligenza Artificiale.

Paolo: Mi diceva che l'intelligenza artificiale viene utilizzata principalmente in ambito Operation. Può darmi maggiori informazioni in merito?
Dott. Foglieni: L'intelligenza Artificiale viene sfruttata direttamente sugli impianti produttivi. Tra un mese lanceremo un nuovo progetto. Prima l'operatore aveva una "ricetta" su un foglio cartaceo e doveva impostare tutti i tiraggi del macchinario seguendo quelle indicazioni. Questi tiraggi facevano delle aggiunte pesanti delle quantità che venivano innestate nel miscelatore, per poi fare il prodotto finito tramite miscelazione. Ad oggi, tramite questo PLC SINOTTICO che si interfaccia tramite un *sequel bridge*, stiamo implementando una rivoluzione che ci permetterà direttamente dalla formula associata alla singola commessa, di caricare su PLC la distinta presente a sistema e quindi automaticamente effettuare il tiraggio. Non ci sarà più l'inserimento manuale della distinta da parte dell'operatore, ma questo si limiterà a stampare la commessa e leggerla tramite una pistola BARCODE, grazie alla quale tutti i dati verranno importati su PLC. L'operatore farà un check per vedere che tutto sarà in ordine ed il processo verrà avviato in maniera automatizzata, aumentando in questo modo la stabilità e la qualità del processo; ma anche la velocità: con una lettura tramite pistola BARCODE si riescono ad evitare circa trenta operazioni manuali fatte in precedenza.

Paolo: Grazie all'utilizzo dell'Intelligenza Artificiale avete ottenuto risultati importanti in termini di velocita e qualità del processo. Ed in termini di fatturato?
Dott. Foglieni: Valutare l'impatto dell'AI nel fatturato non è semplice, perché il fatturato della Bellini Spa cresce da sei anni di fila in doppia cifra, circa del 13-14% annuo. Si è passati da un fatturato di 13 milioni nel 2011 ad uno di quasi 29 milioni nel 2018. Quindi non è semplice capire quanto la spinta sia data da investimenti fatti in Intelligenza Artificiale, quanto dalla ricerca e sviluppo e quanto dalla nostra rete commerciale. Sicuramente tutto l'insieme sarà stato fondamentale, ma crescendo così tanto è difficile identificare l'impatto di ogni singola componente nel risultato finale.

Paolo: Da quanto tempo state utilizzando l'intelligenza artificiale e che difficoltà avete riscontrato nell'introdurla in azienda?
Dott. Foglieni: Abbiamo iniziato ad utilizzarla nel 2017, quindi circa da due anni e mezzo. La principale difficoltà riscontrata nell'introduzione e gestione dell'Intelligenza Artificiale, da un punto di vista maggiormente manageriale, è stata quella di farne comprendere il ruolo all'operatore. E' stato complesso dimostrare al lavoratore che il ruolo dell'intelligenza artificiale non è la mera sostituzione dell'operatore, ma è principalmente un aiuto ed un supporto al loro lavoro.
Un ulteriore problema, ovviamente, è stato quello della progettazione a monte: non è semplice infatti capire quali siano le proprie esigenze in termini di IA e farle combaciare con quello che offre il mercato. Anche mettere in campo la soluzione definita come ideale non è semplice, ma confermo che la maggior difficoltà riscontrata è stata nel confronto con l'operatore.

Paolo: Avete un reparto dedicato per la gestione dell'Intelligenza Artificiale?
Dott. Foglieni: No, nella nostra azienda non c'è un reparto ad hoc che si occupa della gestione dell'intelligenza artificiale. Ce ne occupiamo io e un mio collega, in particolare sulla parte Operation. Siamo una PMI di circa 55 dipendenti, quindi non ci sarebbe possibile dedicare una figura completamente alla gestione dell'IA.
La gestione dell'AI si basa su *attività progettuali* che seguiamo al fianco delle nostre mansioni quotidiane.

Paolo: L'introduzione dell'Intelligenza Artificiale ha in qualche modo cambiato la relazione con i vostri fornitori e clienti?
Dott. Foglieni: In parte per il cliente. Abbiamo introdotto in area Sales un nuovo strumento per la ricezione degli ordini; questo permette al cliente di inviare direttamente l'ordine e le commesse varie tramite un portale web, e non più tramite la solita email. Abbiamo unificato gran parte degli ordini di ingresso su questo portale evitando errori di inserimento; infatti maggiore è il passaggio di dati maggiore è la probabilità di errore. Ed ovviamente questo ci ha aiutato a risparmiare del tempo.
Anche questo ci ha permesso di guadagnare molta efficienza, oltre che di efficacia, grazie alla riduzione del numero di errori.

Paolo: In ambito Operation, avete sfruttato l'Intelligenza Artificiale anche per avere dati in tempo reale sulla necessità di effettuare una manutenzione straordinaria degli impianti produttivi?

Dott. Foglieni: Non ancora, è un'idea che abbiamo intenzione di sviluppare in futuro, ma attualmente non è in funzione.
Paolo: Gli investimenti degli scorsi anni effettuati nel mondo dell'Industria 4.0 hanno facilitato l'implementazione dell'Intelligenza Artificiale?
Dott. Foglieni: Si, sicuramente. E' stato un punto di rottura importante tra il passato ed il futuro, che ci ha aperto gli occhi, mostrando cosa si può ottenere con l'utilizzo dell'intelligenza artificiale rispetto alla conduzione più tradizionale dell'attività.
Per utilizzare l'Intelligenza artificiale siamo anche molto più attenti nella gestione dei dati. Per immagazzinare, trattare e dividere i dati abbiamo introdotto diversi pannelli, tramite software. Questi pannelli servono per il monitoraggio dei dati e attività di *Business Intelligence* dedicate ad ogni reparto.

Paolo: Le vostre competenze interne sono state sufficienti a gestire l'implementazione dell'Intelligenza Artificiale?
Dott. Foglieni: No non sono state sufficienti. Noi capi eravamo coadiuvati, nella gestione dell'IA, dai fornitori e da consulenti esterni; questo è stato necessario per acquisire le competenze che noi inizialmente non avevamo. Questa esperienza è stata quindi anche utile ad arricchire le nostre competenze.

Paolo: Avete quindi avuto un affiancamento generale nell'implementare l'IA?
Dott. Foglieni: Siamo stati affiancati, ma non a livello generale. L'affiancamento ha riguardato singoli processi. Adesso siamo diventati abbastanza autonomi.

Paolo: L'introduzione dell'intelligenza Artificiale ha comportato dei cambiamenti organizzativi interni?
Dott. Foglieni: Si, l'introduzione dell'intelligenza Artificiale ha comportato degli spostamenti di personale da alcuni reparti ad altri. C'è stato un processo di "rimansionamento" di alcune figure che prima erano richieste in specifici reparti e che poi non sono più state necessarie in quella specifica mansione, per l'introduzione dell'Intelligenza Artificiale e dell'automazione.
Nessuno però è stato condotto fuori dall'azienda.

Intervista realizzata da Paolo Inì.
Dipartimento di Scienze Economiche ed Aziendali Marco Fanno - Università di Padova.

Appendix B (English Version):

Interview with Mr. Cammarota, UNOX.
Mr. Cammarota's role: *Research Manager*

Paolo: Can you briefly describe the activity carried out by Unox, its products and its market?
Mr. Cammarota: Unox is a company that produces and sells professional ovens, and generally provides services to all businesses that deal with food, from the restaurant that needs an oven to satisfy just a few seats, to large chains like McDonald's and Subway.
Passing through canteens, hotels and supermarkets. The company has about 690 employees, of which around 200 are in Italy, where the company focuses on the areas of Operation and Innovation. We have a sales force abroad.

Paolo: Entering into the world of Artificial Intelligence, how and in what area of the company is it mainly used?
Mr. Cammarota: Artificial Intelligence is present in two areas: in the research area and in the IT area. In the IT area, Artificial Intelligence is mainly used in the field of Business Intelligence. Almost all our products are connected to the internet, and we provide customers who decide to connect their oven to the internet 4 years warranty; all the information that the oven records and measures are useful: both data on the temperatures of the components, that allow us to do diagnostics and maintenance in a predictive manner, and usage data that allow us to create insights to give our customers to use to the fullest the oven. Examples may include the following: the combi-oven, which is our flagship product, is capable of cooking with both hot air and steam convection; if we see that one of our customers does not use, for example, the steam function, we send him an email and a notification on the app saying that the oven is able to carry out different types of cooking and we also suggest a potential recipe. The consumer through his phone can send the recipe to the oven and try the steam recipe. Another example may be the case in which the customer uses the oven only during the day, in this case we communicate to the customer the possibility to expand his business thanks to the possibility of making a night cooking in total autonomy. This data analysis and advice generation is done in IT.
In the research part we are working on hardware technologies, such as the machine vision, which is a system that allows the oven, with the use of a camera, to automatically recognize the food that is inserted and therefore autonomously launch the right cooking program and

understand the degree of cooking of the food. We are also working on voice control technology, which uses technologies that are in the world of machine learning and deep learning and therefore fall within the scope of Artificial Intelligence.

Paolo: How long have you been using Artificial Intelligence and what difficulties have you encountered in introducing it into the company?
Mr. Cammarota: We have been working on it for at least three years. As far as the greatest difficulties are concerned, it must be emphasized that a paradigm shift is necessary to bring Artificial Intelligence into a "mechanical" company. If fifteen years ago the company was only looking for mechanical engineers, now instead it is looking for staff able to use these innovative technologies.
Looking also at the employees' park, if in the past the innovation area was 99% composed of mechanical engineers, now it is composed of approximately the same number of mechanical engineers and other profiles able to exploit the technologies of the future.
Also in Padua are flourish Universities offering degree programs in Data Science.

Paolo: Did you have difficulty finding personnel capable of using and managing Artificial Intelligence?
Mr. Cammarota: Initially yes. Now, however, it is a growing area, so finding staff has become easier.

Paolo: What were the main results obtained thanks to the use of Artificial Intelligence?
Mr. Cammarota: Unox has not yet presented to the market the products that heavily use Artificial Intelligence; we think, however, that this technology will lead us to an important growth in terms of turnover. This market is a fairly conservative market, therefore quite resistant to changes; the main reason lies in the fact that the oven is the main production machine in the kitchen, so if the oven were to give problems it would be like stopping the production line of a company.
We believe that in a certain number of years an oven that does not use technologies related to Artificial Intelligence will be totally obsolete and unsellable.

Paolo: How much, the investments in Artificial Intelligence, have increased the total investments made by the company?
Mr. Cammarota: In the team that I am coordinating, the introduction of Artificial Intelligence had a very strong impact both in terms of time spent and in terms of resources.

Paolo: Has the introduction of Artificial Intelligence led to internal organizational changes?
Mr. Cammarota: Yes, this technology shifts the center of gravity of the skills that are needed in a company. The impact does not only concern the skills but also the strategic resources, in terms of the Business Model Canvas: the key resources move in the areas of Artificial Intelligence.

Paolo: Why your company decided to invest on the Artificial Intelligence?
Mr. Cammarota: Everything comes from the need to make a product with certain characteristics; characteristics that can be present only through Artificial Intelligence. Unox is currently much more focused on this aspect, rather than making production processes 4.0.
Our product enters our customer's production process, so making a 4.0 product means giving our customer a 4.0 production process.

Paolo: Has the introduction of Artificial Intelligence changed the relationship with your suppliers and customers in any way?
Mr. Cammarota: The change in the relationship with the customer concerns the insights and coaching that the machine does to the customer. We have started to provide our customers, thanks also to Artificial Intelligence, a digital experience.
We also have a team that develops apps, which offer customers the opportunity to do oven training and to manage data driven cooking: in your app you have all the data on how to use the oven, you know how much you spent and how much you saved on your bill thanks to the adoption of the combined oven.
Artificial Intelligence is present in the machine learning mechanisms that analyze data and provide insights to the customer.
On the supplier side, the change concerned the need to contact external consultants or external bodies such as universities. We did two hackathons on Artificial Intelligence.
The electronics suppliers, however, have not changed, but we have begun to acquire more performing objects and with greater computing power.

Paolo: How is Artificial Intelligence internally managed? Do you have a dedicated team?
Mr. Cammarota: In the research, software engineering and IT team, we have staff who are mainly involved in Artificial Intelligence.
We also have a team called Digital Experience that deals with the creation of the App.

Paolo: Have the investments made in the past few years in the world of Industry 4.0 facilitated the implementation of Artificial Intelligence?
Mr. Cammarota: We have been investing in these instruments for a while now. The difference with the past is that now the most advanced equipment is available to everyone, something that did not happen in the past. For example, Google offers platforms, including Tensorflow, totally free and optimized for calculating neural networks.
Today's world provides us with everything needed for the application of these new technologies, what Unox had to do was to create know-how, train people and create all the internal infrastructure to manage this type of project.

Paolo: In the Operation area, have you used Artificial Intelligence to get real-time data on the need to perform maintenance on production facilities?
Mr. Cammarota: We are starting to use Artificial Intelligence also for the maintenance of production plants as well as ovens. Currently, however, this type of maintenance leads to better results in data driven sectors, where it is possible to collect a large quantity of data in order to carry out assessments and analyzes even in the maintenance area. On the contrary, for what concerns the production of the oven, which is a type of production mainly physical drive, it is considered more appropriate a maintenance that requires the "vision" and the direct work of the worker. The operator can check directly if the temperature or if the production standard is not followed. As a result, we currently believe that manual maintenance is more reliable.

Interview made by Paolo Inì.
Department of Economics and Business Sciences "Marco Fanno" - University of Padua.

Appendix B (Italian Version):

Intervista Dott. Cammarota, UNOX.
Ruolo Dott. Cammarota: *Research Manager*

Paolo: Può descrivere brevemente l'attività svolta dalla Unox, i suoi prodotti e il mercato di riferimento?
Dott. Cammarota: Unox è un'azienda che produce e vende forni professionali, ed in generale fornisce servizi a tutti i business che si occupano di cucinare cibo, dalla trattoria che necessita di un forno per soddisfare pochi coperti, a grandi catene come McDonald's e Subway.
Passando per mense, alberghi, supermercati. L'azienda conta circa 690 dipendenti, di cui circa

200 in Italia, nella quale l'azienda si focalizza nelle aree di Operation e di Innovation. All'estero abbiamo invece forza vendite.

Paolo: Entrando nel merito del mondo dell'intelligenza artificiale, in che modo ed in che area dell'azienda viene principalmente utilizzata?
Dott. Cammarota: L'Intelligenza Artificiale è presente in due aree: nell'area di ricerca e nell'area IT. Nell'area IT l'Intelligenza Artificiale viene principalmente utilizzata in ambito di Business Intelligence. Quasi tutti i nostri prodotti escono connessi ad internet, e noi forniamo ai clienti che decidono di connettere il proprio forno ad internet 4 anni di garanzia; tutte le informazioni che il forno registra e misura, sia dati sulle temperature dei componenti che ci consentono di fare della *diagnostica* e della *manutenzione in maniera predittiva*, sia dati di utilizzo che ci consentono di creare degli insights da dare ai nostri clienti per usare al meglio il forno. Degli esempi possono essere i seguenti: il forno combinato, che è il nostro prodotto di punta, è capace di cucinare sia con la convezione di aria calda sia con il vapore; se vediamo che un nostro cliente non utilizza ad esempio la funzione vapore, gli inviamo un'email e una notifica sulla app dicendo che il forno è in grado di svolgere diversi tipi di cottura e suggeriamo anche una potenziale ricetta. Il consumatore tramite telefono può inviare la ricetta al forno e provare la ricetta a vapore. Un altro esempio può essere il caso in cui il cliente utilizza il forno solo di giorno, in quel caso comunichiamo al cliente la possibilità di ampliare il suo business grazie alla possibilità di effettuare una cottura notturna in totale autonomia.
Questa analisi di dati e generazione di advice viene fatta in ambito IT.
Nella parte ricerca stiamo lavorando su tecnologie hardware, come il machine vision, ovvero un sistema che consente al forno, con l'utilizzo di una telecamera, di riconoscere automaticamente il carico che viene inserito e quindi autonomamente lanciare il giusto programma di cottura e di capire il grado di cottura dell'alimento.
Stiamo anche lavorando sulla tecnologia del *voice control*, che sfrutta tecnologie che stanno nel mondo del *machine learning* e del *deep learning* e che quindi rientrano nell'ambito dell'Intelligenza Artificiale.

Paolo: Da quanto tempo state utilizzando l'intelligenza artificiale e che difficoltà avete riscontrato nell'introdurla in azienda?
Dott. Cammarota: Ci lavoriamo da almeno tre anni. Per ciò che riguarda le maggiori difficoltà, bisogna sottolineare che per portare l'intelligenza artificiale in una azienda "meccanica" è necessario un cambio di paradigma. Se quindici anni fa l'azienda cercava solo ingegneri meccanici, adesso invece cerca personale in grado di utilizzare queste tecnologie innovative.

Guardando anche il parco dipendenti, se in passato l'area innovazione era composta al 99% da ingegneri meccanici, adesso è composta all'incirca dallo stesso numero di ingegneri meccanici e altri profili in grado di sfruttare le tecnologie del futuro. Si parla in generale di *Data Science*.
Anche a Padova fioriscono Università che offrono corsi di laurea in Data Science.

Paolo: Avete avuto difficoltà a trovare personale capace di utilizzare e gestire l'Intelligenza Artificiale?
Dott. Cammarota: Inizialmente si. Adesso invece è un ambito in crescita quindi trovare personale è diventato più semplice.

Paolo: Quali sono stati i principali risultati ottenuti grazie all'utilizzo dell'intelligenza artificiale?
Dott. Cammarota: Unox deve ancora "uscire" sul mercato con prodotti che utilizzano pesantemente l'Intelligenza Artificiale; pensiamo però che questa tecnologia ci porterà ad una importante crescita in termini di fatturato. Questo mercato è un mercato abbastanza conservativo, quindi abbastanza resistente alle modifiche ed ai cambiamenti; la ragione principale risiede nel fatto che il forno è la principale macchina di produzione nella cucina, quindi se il forno dovesse dare problemi sarebbe come se si bloccasse la linea di produzione di una azienda.
Riteniamo che in un certo numero di anni un forno che non utilizzi le tecnologie legate all'Intelligenza Artificiale sarà totalmente obsoleto ed invendibile.

Paolo: Quanto, gli investimenti in Intelligenza Artificiale, hanno incrementato il totale degli investimenti effettuati dall'azienda?
Dott. Cammarota: Nel team da me coordinato l'introduzione dell'Intelligenza Artificiale ha avuto un impatto molto forte sia in termini di tempo impiegato che in termini di risorse.

Paolo: L'introduzione dell'intelligenza Artificiale ha comportato dei cambiamenti organizzativi interni?
Dott. Cammarota: Si, questa tecnologia sposta molto il baricentro delle competenze che ci sono all'interno di una azienda. L'impatto non riguarda solamente le competenze ma anche le risorse strategiche, in termini di *Business Model Canvas*: le risorse chiave si spostano molto nelle aree dell'Intelligenza Artificiale.

Paolo: Quali sono state le motivazioni legate all'adozione dell'Intelligenza Artificiale?
Dott. Cammarota: Nasce tutto dalla necessità di fare un prodotto con determinate caratteristiche; caratteristiche che possono essere presenti solo attraverso l'Intelligenza Artificiale. Unox attualmente è molto più focalizzata sul questo aspetto, piuttosto che rendere 4.0 i processi produttivi.
Il nostro prodotto entra nel processo produttivo del nostro cliente, quindi fare un prodotto 4.0 significa dare al nostro cliente un processo produttivo 4.0.

Paolo: L'introduzione dell'Intelligenza Artificiale ha in qualche modo cambiato la relazione con i vostri fornitori e clienti?
Dott. Cammarota: Il cambiamento nella relazione con il cliente riguarda gli insights e il coaching che la macchina fa al cliente. Abbiamo iniziato a fornire al nostro cliente, grazie anche all'Intelligenza Artificiale, un'esperienza digitale.
Abbiamo anche un team che sviluppa App, che offrono al cliente la possibilità di fare training sul forno e per gestire il *data driven cooking:* nella tua app hai tutti i dati sull'utilizzo del forno, sai quanto hai speso e quanto hai risparmiato di bolletta grazie all'adozione del forno combinato.
L'Intelligenza Artificiale è presente nei meccanismi di machine learning che analizzano i dati e forniscono gli insights al cliente.
Lato supplier, il cambiamento ha riguardato la necessità di rivolgerci a dei consulenti esterni o ad enti esterni quali le università. Abbiamo fatto due hackathon sull'Intelligenza Artificiale.
I fornitori di elettronica comunque non sono variati, abbiamo però iniziato ad acquisire oggetti più performanti e con maggiore potenza di calcolo.

Paolo: Come viene gestita internamente l'Intelligenza Artificiale? Avete un team dedicato?
Dott. Cammarota: Nel team di ricerca, di software Engeneering e di IT, abbiamo del personale che si occupa principalmente di Intelligenza Artificiale.
Abbiamo inoltre un team che si chiama Digital Experience che si occupa della realizzazione delle App.

Paolo: Gli investimenti degli scorsi anni effettuati nel mondo dell'Industria 4.0 hanno facilitato l'implementazione dell'Intelligenza Artificiale?
Dott. Cammarota: Si abbiamo già da un po' iniziato ad investire su questi strumenti. La differenza con il passato sta che ormai le strumentazioni più avanzate sono a disposizione di tutti, cosa che in passato non accadeva. Ad esempio Google offre delle piattaforme, tra le quali

Tensorflow, totalmente gratuite e ottimizzate per fare calcoli di reti neurali.
Il mondo di oggi ci fornisce tutto il necessario per le applicazioni di queste nuove tecnologie, quello che ha dovuto fare Unox è stato creare *knowhow*, formare le persone e creare tutta l'infrastruttura interna per gestire questa tipologia di progetti.

Paolo: In ambito Operation, state sfruttato l'Intelligenza Artificiale anche per avere dati in tempo reale sulla necessità di effettuare una manutenzione degli impianti produttivi?
Dott. Cammarota: Stiamo iniziando ad utilizzare l'Intelligenza Artificiale anche per la manutenzione degli impianti produttivi oltre che dei forni. Attualmente però questa tipologia di manutenzione porte migliori risultati in settori *data driven*, dove si riesce a raccogliere una quantità di dati tale da poter svolgere valutazioni ed analisi anche nel mondo della manutenzione. Contrariamente, per ciò che riguarda la produzione del forno che è una tipologia di produzione maggiormente *physical drive,* si ritiene più appropriata una manutenzione che richieda la "visione" e l'operato diretto del lavoratore. L'operatore può controllare in maniera diretta se la temperatura o se non viene seguito lo standard produttivo.
Di conseguenza attualmente riteniamo più affidabile la manutenzione manuale.

Intervista realizzata da Paolo Inì.
Dipartimento di Scienze Economiche ed Aziendali "Marco Fanno" - Università di Padova.

Appendix C (English Version):

Interview with Mr. Pizzochero, SEA Vision.
Mr. Pizzochero's role: Business Intelligence Software Product Responsible

Paolo: Can you briefly describe the activity carried out by SEA Vision, its products and its market?
Mr. Pizzochero: Generally speaking, SEA Vision is in charge of carrying out quality checks on pharmaceutical packaging lines.
We, with the help of video cameras, are going to check, along the whole pharmaceutical packaging chain, that the drug is present, that it is intact, that it is of the correct shape and color, that the external packaging is intact and contains all the necessary.
We also check that the data printed on the package are the correct ones. We are therefore able to carry out every type of control that can be called "visual": in addition to those already mentioned, we check the fluid level inside the vial; we are also able to control the correctness of the data printed on the label applied to cylindrical containers, which therefore require more sophisticated reading technologies. We are therefore able to carry out any kind of visual inspection. Then there is another big chunk of our business that concerns the serialization part. Nowadays, regulations at European and world level have required complete traceability of the drug along the entire supply chain. It is therefore necessary, starting from the pharmacist, to go back up in the entire supply chain, till the producer. This is essential to combat the phenomenon of counterfeiting. Counterfeiting does not have an economic impact only, but it also has the crucial problem related to consumer health: at best a counterfeit drug does not produce the desired effect, at worst it produces results that are even harmful to the patient's health. To avoid this, we have developed systems for the serialization of the drug, known as tracken phase, which we need to trace every single package of medicine in a unique way.

Paolo: Entering into the world of Artificial Intelligence, how and in what area of the company is it mainly used?
Mr. Pizzochero: The introduction of the latest regulations, at national level, related to Industry 4.0, has allowed us to base our business on these new technologies. In fact, important tax breaks have been envisaged for those who have adopted the "industry 4.0" criteria: these include the possibility of controlling the machinery through a control software and, secondly, of acquiring the data, analyze and exploit them to make predictions thanks to the use of Artificial Intelligence.

So Artificial Intelligence is crucial for us in all the activities I listed above.
The control of machinery through software is an activity we have been doing for some time; instead we have recently started using Artificial Intelligence to analyze the data coming from the machinery to make forecasts. In practice we have created an AI software able to control the machines and acquire the data during their operation throughout the day, to be able to exploit the data in order to perform different operations.
Our fundamental objective is to fully exploit the Artificial Intelligence for data collection and analysis. For our business the "data" collected by the machinery has a very high value, therefore managing it in the appropriate manner is fundamental.
When during the process of visual inspection or serialization of the drug the machinery follows incorrect behaviors and does not respond as expected, it is necessary to understand what are the causes of this in order to provide a solution.
In the first instance, the AI uses the data collected by the machinery to create reports, which are essential to understand what happened. Subsequently it analyzes the collected data and extracts information to predict what will happen in the future, analyzing how the systems behaved. Finally, Artificial Intelligence has the fundamental role of intervening in the face of unexpected machine behavior and correcting it to follow the correct process line.
In summary, the role for the Artificial Intelligence in SEA Vision is that of collecting and analyzing data, making forecasts and correcting action in the event of unexpected attitudes.

Paolo: How long have you been using Artificial Intelligence and what difficulties have you encountered in introducing it into the company?
Mr. Pizzochero: The application process of Artificial Intelligence are still in the research and development phase. The main problem in the application of such advanced technology lies in the lack of vertical skills able to fully manage it. We did not have such expertise within the company, so we had to train. Furthermore, it is very difficult to find personnel with the skills necessary to manage these technologies. We therefore had to turn to external companies that make the management of such advanced technologies their core business.

Paolo: Has the introduction of Artificial Intelligence led to internal organizational changes?
Mr. Pizzochero: The introduction of Artificial Intelligence certainly did not have a negative impact within the company, not even as regards the number of employees.
Usually in almost all companies that bring such radical innovations as this, especially in the core business, many employees are then left at home, but this was not ours case.

Instead it has had a positive impact for us: it is a new slice of business and therefore we had to hire and we are still hiring new staff with advanced skills related to the AI world.

Paolo: What were the main reasons that led you to invest in Artificial Intelligence?
Mr. Pizzochero: Surely, as always happens when talking about "for profit" companies, the main motivation for such a radical change is business.
There was a business need, in addition to the fact that our customers ask us for these innovations. Furthermore, not many of our competitors offer this service. We exploited a business opportunity. We are not a research institution, nor a non-profit organization, so the choices made followed the logic of creating income.

Paolo: What were the main results obtained following the implementation of Artificial Intelligence?
Mr. Pizzochero: At this stage the process is not yet fully mature, so the result it produced is a strong interest from everyone: our customers and potential customers. There is a growing interest in these issues, and there is a very strong interest in our product. To talk about numbers on the market it is still a bit early, but the prospects for growth also in terms of turnover are all there.

Paolo: Has the introduction of Artificial Intelligence changed the relationship with your suppliers and customers in any way?
Mr. Pizzochero: On the supplier side, the implementation of this new technology has not brought changes. The main changes, on the other hand, concern the customer who had to adapt to this new technology. The role of data collection is crucial, therefore it is necessary that the customer also exploits partly compatible technology with ours. As I said earlier, the main impact was neither in relation to customer nor in relation to the supplier, but mainly in the search for personnel sufficiently skilled.

Paolo: Have the investments made in the past few years in the world of Industry 4.0 facilitated the implementation of Artificial Intelligence?
Mr. Pizzochero: They certainly created a mindset that gave us the possibility to introduce a more radical innovation such as the Artificial Intelligence.

Interview made by Paolo Inì.
Department of Economics and Business Sciences "Marco Fanno" - University of Padua.

Appendix C (Italian Version):

Intervista Dott. Pizzochero, SEA Vision.
Ruolo Dott. Pizzochero: Business Intelligence Software Product Responsible.

Paolo: Può descrivere brevemente l'attività svolta dalla SEA Vision, i suoi prodotti e il mercato di riferimento?
Dott. Pizzochero: In linea generale, la SEA Vision si occupa di effettuare controlli di qualità su linee di confezionamento farmaceutico.
Noi, con l'ausilio di telecamere e videocamere andiamo a controllare, lungo tutta la filiera del confezionamento farmaceutico, che il farmaco sia presente, che sia integro, che sia della forma e del colore corretto, che la confezione esterna sia integra e che contenga tutto il necessario. Inoltre controlliamo che i dati stampati sulla confezione siano quelli corretti. Riusciamo quindi a svolgere ogni tipo di controllo che può essere definito "visivo": oltre a quelli già citati, controlliamo il livello di fluido all'interno della fiala; siamo anche in grado di controllare la correttezza dei dati stampati sull'etichetta applicate a contenitori cilindrici, che quindi richiedono livelli di lettura più sofisticati. Siamo quindi in grado di effettuare qualsiasi tipo di controllo visivo.
C'è poi un'altra grossa fetta del nostro business che riguarda la parte di *serializzazione*. Da un po' di tempo le normative, a livello europeo e mondiale, impongono una completa tracciabilità del farmaco lungo l'intera filiera. E' quindi necessario, partendo dal farmacista, risalire lungo tutta la filiera fino ad arrivare al produttore. Questo è fondamentale per combattere il fenomeno della contraffazione. La contraffazione non ha un impatto solo a livello economico, ma ha anche il problema cruciale legato alla salute del consumatore: nella migliore delle ipotesi un farmaco contraffatto non produce l'effetto desiderato, nella peggiore produce dei risultati addirittura dannosi per la salute del paziente. Per evitare ciò noi abbiamo realizzato dei sistemi per la serializzazione del farmaco, detti *tracken phase,* che ci servono per tracciare in maniera univoca ogni singola confezione di farmaco.

Paolo: Entrando nel merito del mondo dell'intelligenza artificiale, in che modo ed in che area dell'azienda viene principalmente utilizzata?
Dott. Pizzochero: L'introduzione delle ultime normative, a livello nazionale, relative all'Industria 4.0, ci ha permesso di basare il nostro business su queste nuove tecnologie. Sono infatti stati previsti importanti sgravi fiscali per chi si fosse dotato dei criteri di "industria 4.0": tra questi la possibilità di controllare i macchinari tramite un software di controllo e in

seconda battuta di acquisire i dati, analizzarli e sfruttarli per effettuare “previsioni” grazie all’utilizzo dell’intelligenza artificiale.
Quindi l’intelligenza artificiale per noi è cruciale in tutte le attività che le ho elencato precedentemente.
Il controllo dei macchinari tramite software è un’attività da noi svolta già da tempo; abbiamo invece iniziato da poco a sfruttare l’Intelligenza Artificiale per analizzare il dato proveniente dal macchinario e fare forecasts. In pratica abbiamo creato un software AI in grado di controllare le macchine ed acquisirne i dati durante il loro funzionamento nell’intera giornata, in modo da poter sfruttare i dati per svolgere diverse operazioni.
Il nostro obiettivo fondamentale è quello di sfruttare a pieno l’Intelligenza Artificiale per la raccolta ed analisi di dati. Per il nostro business il “dato” raccolto dal macchinario ha un valore molto alto, di conseguenza gestirlo nella maniera appropriata è fondamentale.
Quando durante il processo di controllo visivo o di serializzazione del farmaco il macchinario segue dei comportamenti errati e non risponde come atteso, bisogna capire quale siano le cause di ciò per provvedere ad una soluzione.
In prima battuta l’AI sfrutta i dati raccolti dal macchinario per creare dei report, fondamentali per capire cosa è accaduto. Successivamente analizza i dati raccolti ed estrae informazioni per predire quello che accadrà in futuro, analizzando come si sono comportati i sistemi. Infine, l’Intelligenza Artificiale ha il ruolo fondamentale di intervenire a fronte di comportamenti inattesi del macchinario e di correggerli in modo tale da seguire la linea di processo corretto.
Riassumendo, il ruolo per la SEA Vision dell’Intelligenza Artificiale è quello della raccolta e analisi di dati, realizzazione di forecasts e di intervento di correzione in caso di atteggiamenti inattesi.

Paolo: Da quanto tempo state utilizzando l’intelligenza artificiale e che difficoltà avete riscontrato nell’introdurla in azienda?
Dott. Pizzochero: Per il processo di applicazione dell’Intelligenza Artificiale siano ancora in fase di ricerca e sviluppo. Il problema principale nell’applicazione di una tecnologia così avanzata sta nella mancanza di competenze verticali in grado di gestirla a pieno. Noi non avevamo all’interno dell’azienda personale con tali competenza, di conseguenza abbiamo dovuto formarci. Inoltre c’è molta difficoltà a reperire personale con le skills necessarie a gestire queste tecnologie. Abbiamo quindi dovuto, giocoforza, rivolgerci ad aziende esterne che fanno della gestione di tecnologie così avanzate il loro core business.

Paolo: L'introduzione dell'intelligenza Artificiale ha comportato dei cambiamenti organizzativi interni?
Dott. Pizzochero: L'introduzione dell'Intelligenza Artificiale non ha avuto sicuramente un impatto negativo all'interno dell'azienda, nemmeno per ciò che riguarda il numero di dipendenti.
Di solito in quasi tutte le aziende che portano innovazioni così radicali come questa, in particolare nel core business, molti dipendenti vengono poi lasciati a casa, ma da noi non è stato così.
Invece per noi ha avuto un impatto positivo: è una nuova fetta di business e quindi abbiamo dovuto assumere e stiamo tuttora assumendo nuovo personale con competenze avanzate legate al mondo AI.

Paolo: Quali sono state le principali motivazioni che vi hanno spinto ad investire nell'Intelligenza Artificiale?
Dott. Pizzochero: Sicuramente, come sempre accade parlando di aziende "for profit", la motivazione principale di un cambiamento così radicale è il business.
C'era una esigenza di business, oltre al fatto che i nostri clienti ci chiedono queste innovazioni. Inoltre tra i nostri competitors non sono in molti ad offrire questo servizio. Ci si è presentata una opportunità di business e l'abbiamo sfruttata. Noi non siamo un ente di ricerca, né una no profit, quindi le scelte effettuate seguono la logica della creazione di rendita.

Paolo: Quali sono stati i principali risultati ottenuti a seguito dell'implementazione dell'Intelligenza Artificiale?
Dott. Pizzochero: In questa fase il processo non è ancora completamente maturo, quindi il risultato che ha prodotto è un forte interesse da parte di tutti, nostri clienti e potenziali clienti. C'è un interesse sempre crescente rispetto a questi temi, e c'è un interesse molto forte verso il nostro prodotto. Per parlare di numeri sul mercato è ancora un po' presto, però le prospettive per una crescita anche in termini di fatturato ci sono tutte.

Paolo: L'introduzione dell'Intelligenza Artificiale ha in qualche modo cambiato la relazione con i vostri fornitori e clienti?
Dott. Pizzochero: Dal lato del fornitore, l'implementazione di questa nuova tecnologia non ha portato grossi cambiamenti. I cambiamenti principali riguardano invece il cliente che comunque ha dovuto in parte adattarsi alla nuova tecnologia adottata. Il ruolo della raccolta dati è cruciale, di conseguenza è necessario che il cliente sfrutti anche in parte tecnologia compatibili con la

nostra. Come dicevo precedentemente, l'impatto principale non è stato né in relazione al cliente né in relazione al fornitore, ma principalmente nella fase di ricerca di personale sufficientemente competente.

Paolo: Gli investimenti degli scorsi anni effettuati nel mondo dell'Industria 4.0 hanno facilitato l'implementazione dell'Intelligenza Artificiale?
Dott. Pizzochero: Sicuramente hanno permesso di creare una forma mentis tale da riuscire meglio ad introdurre una innovazione più radicale come l'Intelligenza Artificiale.

Intervista realizzata da Paolo Inì.
Dipartimento di Scienze Economiche ed Aziendali "Marco Fanno" - Università di Padova.

Appendix D (English Version):

Interview with Mr. Tamburini, SPEA Spa.
Mr. Tamburini's role*: Head of Research R&D Department*

Paolo: Can you briefly describe the activity carried out by SPEA Spa, and how is Artificial Intelligence applied within your business?
Mr. Tamburini: First of all it is important to underline that our activity does not involve the practical application of Artificial Intelligence systems in production processes, but what we do is a fundamental link in the chain of development of cognitive systems, that are based on data from different sources. We work on any type of sensor.
SPEA Spa produces machines that are used to test electronic boards, circuits and components. Our company deals with the mechanics, electronics and software necessary to control these machines. We also manufacture machines to test components and devices that our customers need to produce the technologies of the future.
I give you an example: if you take a latest-generation mobile phone, within this you will find from two to five cameras, pressure sensors, humidity, temperature, compasses, microphones, light and proximity sensors. All these sensors are manually integrated into one or more electronic circuits that are tested one by one, not only to be certain of their operation, but also to assess whether they respond to the physical stimulus for which they were designed. For example, it is important to check that an accelerometer feels the force of gravity and so on. All these devices are tested one by one. Consequently, when our customers need to make these new generation devices, they know that one of the fundamental steps is to test the operation of this device and the sensors that characterize it.
So, those who design new-generation devices come to us to test it.
For example, in next-generation mobile phones there will be microphones that, based on intelligent software, will be able, in a concert, to isolate the singer's voice from all the noise of the crowd. Consequently, to do this, it is necessary that the software is able, autonomously and intelligently, to recognize the different frequencies of the various sounds.
Many of our customers are already doing projects in this field. If these phones were to go out in two to three years, the realization process must begin now. The "testing" phase is also part of the process. So, entering into the merits of Artificial Intelligence, I give an example linked to autonomous driving. The completely autonomous driving is entirely based on systems that are able to replace the typically human abilities in the interaction with the surrounding environment.

So, it is essential that the system is able to make the appropriate decisions based on information that is obvious to humans, but that for a cognitive system are not. For example, a human who sees a yellow school bus knows that he must increase attention because a child could cross the road by surprise, which is not obvious for a non-human system.
So, if on one hand an intelligent system is able to identify an obstacle and brake with a reaction time lower than that of a human, then the level of trust on this aspect can be very high, on the other there is a whole world in which the interpretation of the human brain is much more complex to be returned with a cognitive algorithm.
The idea of the self-driving car of the near future, with intelligent cognitive systems that simulate and emulate human intelligence, is based entirely on sensors. These sensors will be tested one by one, especially when people's safety is at stake.
If with the mobile phone the reliability of the sensor has an impact at the image and market level, with the self-driving car the consistency of the sensor is crucial for the life of the individual.
All systems based on artificial intelligence pass from sensors that produce and provide the system with the information that man provides through the senses; all these sensors must be tested to ensure that they respond to the physical stimulus for which they were designed.
It is precisely in testing the various sensors our relationship with the world of artificial intelligence.
We produce a system that tests a sensor by creating a machine capable of handling the greatest possible number of sensors in the shortest possible time in order to reduce the cost of the test.
However, in our machines we do not use artificial intelligence systems.

Paolo: From what you told me it is therefore possible to say that you do not make direct use of Artificial Intelligence, but provide services to your customers that allow them to exploit it?
Mr. Tamburini: Exactly. In particular, they allow our customers to produce systems based on cognitive solutions and artificial intelligence.
Most of this intelligent software are characterized by self-learning systems, so they continue to "learn" even after they are put on the market. Almost everyone has Google Home or Alexa at home, cognitive systems that emulate the human. All this is possible because the microphone integrated in Google Home must be able, during the reproduction phase of sound as a speaker, to recognize the individual who says "ok Google", and consequently must stop playback and activate. This type of microphone is an electronic component that must be tested with our machines. It is therefore necessary to create a machine that replicates reality in the most "faithful" way possible.

Paolo: What are the timelines needed to conclude a project of this kind? Which I imagine is characterized by different "failures", before finding the way to go and getting the desired result.
Mr. Tamburini: The test time of a device, which may vary slightly depending on the physical stimulus to which it must be subjected, is usually a few seconds. Hundreds are tested in parallel, so the time per component is extremely low, in the order of milliseconds.
If a component is defective it is thrown away. Our obligation is to test them as quickly as possible. It is necessary to test the components because the manufacturer cannot afford to send non-functioning sensors to the market. The test however, from the point of view of those who produce machinery, is a pure cost, as it does not add value to the final product; if this had already been a perfectly functioning product during the production phase, the test would not have been necessary.
Consequently, the requirement requested by the customer is that the cost of the test be as low as possible; to obtain it is necessary that the test time is as low as possible.
The test is therefore an integral part of the production process, but must not create a bottleneck in the entire process.
The main challenge with our competitors to get a customer lies in the test time; as well as, of course, reliability.

Paolo: For the purchase of the equipment needed to perform these tests, did you benefit from government incentives related to the Industry 4.0 world?
Mr. Tamburini: Absolutely yes, in two sizes: both with the purchase of equipment that we need for the realization of our machinery, and for the realization in economy of machinery produced by ourselves. For the production of our machines we need other machinery; also on this we have benefited from the incentives on Industry 4.0.
Our machines have all the features required: system connectivity, sensorization and remote control systems.

Paolo: In the testing phase, what is the most impactful cost for your company?
Mr. Tamburini: Surely the biggest cost item in our budget is the cost of personnel. We produce a machine for testing a single type of sensor, therefore the level of customization required is very high. For us it is therefore necessary to have several design teams in parallel, which realize extremely diversified projects.
Ours is a rapidly expanding sector, so we also need an extremely large sales force. The company has over 800 employees.

As the second main item of cost I would say the purchase of raw materials, because our business is part of the metalworking industry.

Interview made by Paolo Inì.
Department of Economics and Business Sciences "Marco Fanno" - University of Padua.

Appendix D (Italian Version):

Intervista Dott. Tamburini, SPEA Spa.
Ruolo Dott. Tamburini: Responsabile Ricerca Finanziata R&D Department

Paolo: Può descrivere brevemente l'attività svolta dalla SPEA Spa, e la modalità con la quale viene applicata l'Intelligenza Artificiale all'interno del vostro business?
Dott. Tamburini: Anzitutto è importante sottolineare che la nostra attività non comporta l'applicazione pratica di sistemi di Intelligenza Artificiale nei processi produttivi, ma quello che noi facciamo è un anello fondamentale nella catena dello sviluppo dei sistemi cognitivi basati su dati provenienti da diversi sorgenti. In particolare lavoriamo su qualsiasi tipologia di sensori.
La SPEA Spa produce macchinari che servono per collaudare schede, circuiti e componenti elettronici. La nostra azienda si occupa della meccanica, l'elettronica e il software necessario al controllo di questi macchinari. Noi realizziamo anche macchine per testare componenti e dispositivi che i nostri clienti hanno necessità di realizzare per produrre le tecnologie del futuro.
Le faccio un esempio: se lei prende un cellulare di ultima generazione, all'interno di questo trova da due a cinque fotocamere, sensori di pressione, umidità, temperatura, bussole, microfoni, sensori di luce e prossimità. Tutto questi sensori sono manualmente integrati in uno o più circuiti elettronici che sono testati ad uno ad uno, non solo per essere certi del loro funzionamento, ma anche per valutare se questi rispondono allo stimolo fisico per il quale sono stati progettati. Ad esempio è importante controllare che un accelerometro senta la forza di gravità e così via.
Tutti questi dispositivi sono testati uno ad uno. Di conseguenza quando i nostri clienti devono realizzare queste dispositivi di nuova generazione, sanno che uno degli step fondamentali è quello di testare il funzionamento di questo dispositivi ed i sensori che li caratterizzano.
Quindi, chi progetta i dispositivi di nuova generazione, viene da noi per testarlo.
Ad esempio, nei cellulari di prossima generazione saranno presenti dei microfoni che, basati su

software intelligenti, saranno in grado, in un concerto, di isolare la voce del cantante da tutto il rumore della folla. Di conseguenza, per fare ciò, è necessario che il software sia in grado, autonomamente ed in maniera intelligente, di riconoscere le diverse frequenze dei vari suoni.

Molti nostri clienti stanno già facendo progetti su questo campo. Se questi cellulari dovessero uscire tra due-tre anni, il processo di realizzazione deve iniziare adesso. Nel processo rientra anche il discorso del “testare”.

Quindi, entrando nel merito dell’Intelligenza Artificiale, faccio un esempio legato alla guida autonoma. La guida completamente autonoma è interamente basata su sistemi che siano in grado di sostituire le capacità tipicamente umane nell’interazione con l’ambiente circostante. Quindi è fondamentale che il sistema sia in grado di prendere le decisioni opportune sulla base di informazioni che sono scontate e ovvie per noi umani, ma che per un sistema cognitivo non lo sono. Ad esempio un umano che vede uno scuolabus giallo sa che deve aumentare l’attenzione perché un bambino potrebbe attraversare di sorpresa la strada, cosa che non è ovvia per un sistema non umano.

Quindi, se da un lato un sistema intelligente è capace di individuare un ostacolo e frenare con un tempo di reazione inferiore a quello di un umano, quindi il livello di fiducia su questo aspetto può essere molto alto, dall’altro c’è tutto un mondo in cui l’interpretazione del cervello umano è molto più complessa da restituire con un algoritmo di natura cognitiva.

L’idea dell’auto a guida autonoma del prossimo futuro, con sistemi cognitivi intelligenti che simulano ed emulano l’intelligenza umano, è basata interamente su sensori. Questi sensori andranno testati uno ad uno, in particolar modo quando è in gioco la sicurezza delle persone.

Se con il cellulare il funzionamento del sensore ha impatto a livello di immagine e di mercato, con l’auto a guida autonoma il funzionamento del sensore è cruciale per la vita dell’individuo.

Tutti i sistemi basati sull’intelligenza artificiale passano da sensori che producono e forniscono al sistema le informazioni che l’uomo fornisce attraverso i sensi; tutti questi sensori devono essere testati per essere certi che rispondano allo stimolo fisico per il quale sono stati progettati.

Sta proprio nel testare i vari sensori la nostra relazione con il mondo dell’intelligenza artificiale. Noi produciamo un sistema che testa un sensore realizzando una macchina in grado di movimentare nel più breve tempo possibile il numero maggiore possibile di sensori in modo da abbattere il costo del test.

Noi però nelle nostre macchine a nostra volta non facciamo uso di sistemi di intelligenza artificiale.

Paolo: Da quello che mi ha detto è quindi possibile affermare che voi non facciate uso diretto dell'Intelligenza Artificiale, ma fornite dei servizi ai vostri clienti che gli permettono di sfruttarla?
Dott. Tamburini: Esattamente. In particolare che permettano ai nostri clienti di produrre sistemi basati su soluzioni cognitive e di intelligenza artificiale, e che quindi permettono poi a tutti noi consumatori di sfruttare questi sistemi.
La maggior parte di questi software intelligenti sono caratterizzati da sistemi di *self-learning*, quindi continuano ad "imparare" anche dopo essere stati messi in commercio. Quasi tutti ormai hanno in casa Google Home o Alexa, sistemi cognitivi che emulano l'umano. Tutto ciò è possibile perché il microfono integrato in Google Home deve essere in grado, nella fase di riproduzione di suono come speaker, di riconoscere l'individuo che dice "ok Google", e di conseguenza deve interrompere la riproduzione ed attivarsi.
Questa tipologia di microfono è un componente elettronico che va testato con le nostre macchine e affinché noi consumatori possiamo usarlo in maniera ottimale, è necessario trovare ed inventare il miglior modo per testare tale strumentazione affinché risponda esattamente a quello che deve fare.
E' necessario quindi creare un macchinario che replichi la realtà nella maniera quanto più "fedele" possibile.

Paolo: Quali sono le tempistiche necessarie a concludere un progetto del genere? Che immagino sia caratterizzato da diversi "fallimenti", prima di individuare la strada da percorrere ed ottenere il risultato sperato.
Dott. Tamburini: Il tempo test di un dispositivo, che può leggermente variare in base allo stimolo fisico al quale deve essere sottoposto, solitamente è di pochi secondi. Se ne testano centinaia in parallelo, di conseguenza il tempo per componente è estremamente basso, nell'ordine dei millisecondi. Se un componente è difettoso si butta, c'è poco da fare.
Il nostro vincolo sta nel testarli nel minor tempo possibile.
E' necessario testare i componenti perché il produttore non può permettersi di mandare nel mercato sensori non funzionanti. Il test però, dal punto di vista di chi produce macchinari, è un costo puro, in quanto non va ad aggiungere valore al prodotto finale; se questo fosse stato prodotto già perfettamente funzionante in fase produttiva, il test non sarebbe stato necessario.
Di conseguenza il requisito richiesto dal cliente è che il costo del test sia il più basso possibile; per ottenere è necessario che il tempo test sia il più basso possibile.
Il test è quindi parte integrante del processo produttivo, ma non deve creare un collo di

bottiglia nell'intero processo.
La sfida principale con i nostri competitors per ottenere un cliente sta proprio nel tempo di test; oltre che, ovviamente, nell'affidabilità.

Paolo: Per l'acquisto della strumentazione necessaria ad effettuare questi test, avete beneficiato degli incentivi governativi inerenti al mondo dell'Industria 4.0?
Dott. Tamburini: Assolutamente si, in due misure: sia con l'acquisto di apparecchiature che ci servono per la realizzazione dei nostri macchinari, sia per la realizzazione in economia di macchinari prodotti da noi stessi. Per la produzione delle nostre macchine abbiamo bisogno di altri macchinari; anche su questo abbiamo beneficiato degli incentivi sull'Industria 4.0.
I nostri macchinari hanno tutte le caratteristiche richieste: connettività dei sistemi, sensorizzazione e sistemi di controllo remoto.

Paolo: Nella fase di testing, qual è il costo più impattante per la vostra azienda?
Dott. Tamburini: Sicuramente la voce di costo maggiore nel nostro bilancio è il costo del personale. Noi produciamo una macchina per il test di una singola tipologia di sensori, di conseguenza il livello di personalizzazione necessario è altissimo. Per noi è quindi necessario avere diversi team di progettistica in parallelo, che realizzano progetti estremamente diversificati.
Il nostro è un settore in forte espansione, quindi anche dal punto di vista dei rapporti commerciali abbiamo bisogno di una forza vendite estremamente ampia: l'azienda conta oltre 800 dipendenti.
Come seconda voce principali di costo direi l'acquisto di materie prime, perché la nostra attività fa parte dell'industria metalmeccanica.

Intervista realizzata da Paolo Inì.
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